LABORATORY PRACTICE

RESEARCH · CONTROL · TEACHING

VOL. 10 No. 2 Published Monthly FEBRUARY 1961

Quicker than an analytical balance more accurate than a simple balance

TORBAL

PRECISION BALANCES

* NO KNIFE-EDGES * NO BEARINGS * NO SERVICING
* EASY DIAL OPERATION * ROBUST * EASILY PORTABLE

BTL complete laboratory service

We are now demonstrating these remarkable American balances all over the country. They give you simple, rapid weighing with direct reading and being very robust can be moved about like no other balance, without loss of accuracy. The complete range includes Model DLT5, capacity 500 g., accuracy 50 mg., price £61. 0. 0; and DLT2, capacity 120 g., accuracy 5 mg., price £67. 10. 0.

Write now for full details and a demonstration on your *bench.*

BAIRD & TATLOCK (LONDON) LIMITED, CHADWELL HEATH, ESSEX, ENGLAND.
Branches in London, Manchester, Glasgow. *Agents in U.K. and all over the world.*
TAS/BT. 98

MAKERS OF FINE FURNACES

Gallenkamp INTRODUCE A NEW RANGE OF 33 MODELS

With over 40 years' experience in design and construction, we have now completely restyled our general purpose furnaces and added several new types to the range. Operating temperatures have been increased and new models introduced for use up to 1,500°C. Larger sizes are now available and furnaces have, in general, greater useful working spaces due to improved design. High performance, coupled with very robust construction and reliability make the furnaces equally suitable for laboratory and industrial applications. We also supply special purpose furnaces for coal and coke testing, differential thermal analysis of minerals, and sulphur and halogen determinations by the Carius method.

- **SELF-CONTAINED FURNACES** with all controls and accessories necessary for efficient operation built into non-corroding asbestolite cases.
- **AUTOMATIC CONTROL** on many furnaces and available as an alternative to manual control on all others. **Safety devices** protect furnace when left unattended 24 hours a day.
- **AUTOMATIC TRANSFORMERS** fitted to all high temperature furnaces.

Gallenkamp 'SUPER HOTSPOT'

Our smallest standard muffle furnace, illustrated on the left, is a new version of the very popular 'Hotspot'. The size of muffle is increased to 4 × 5 × 6 in. and the working temperature raised to 1100°C. This furnace is used widely in technical colleges, school laboratories and dental workshops.

ASK FOR PUBLICATION 620

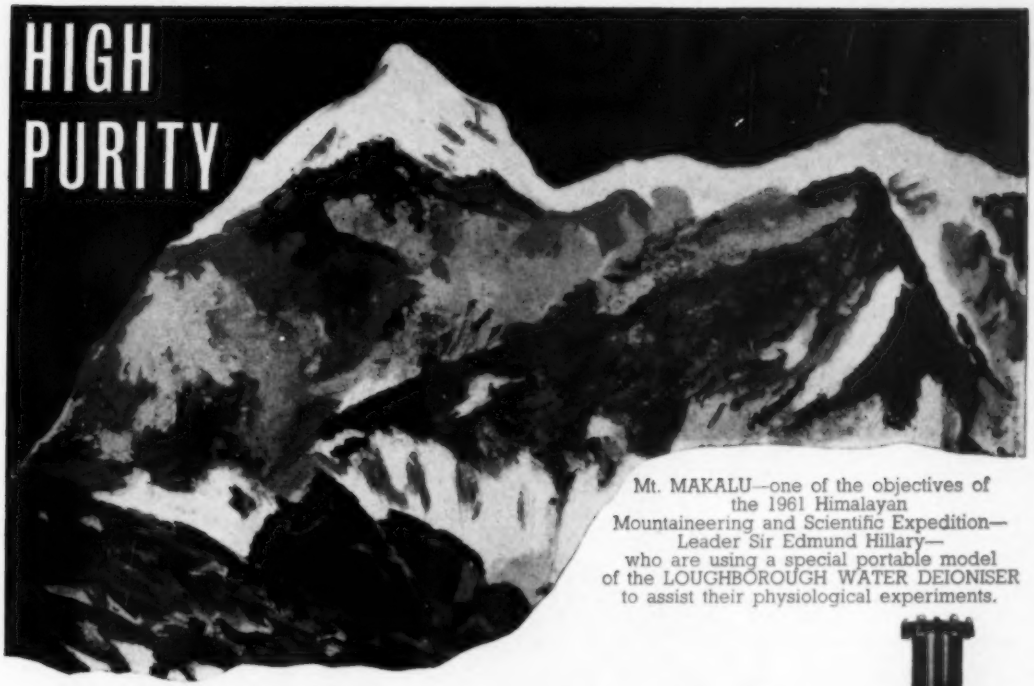
Gallenkamp-Towers

SUPPLY THE WORLD'S LABORATORIES

A. GALLENKAMP & CO. LTD.
Technico House, Sun Street, London, E.C.2
Telephone: BIShopsgate 3211

J. W. TOWERS & CO. LTD.
Victoria House, Widnes, Lancs. *Tel. Widnes* 2040
MANCHESTER: 44 Chapel Street, Salford 3. *Deansgate 4992*
STOCKTON-ON-TEES: 28 Bridge Road. *Stockton 65141*

HIGH PURITY



Mt. MAKALU—one of the objectives of the 1961 Himalayan Mountaineering and Scientific Expedition—Leader Sir Edmund Hillary—who are using a special portable model of the LOUGHBOROUGH WATER DEIONISER to assist their physiological experiments.

FOR HIGH PURITY WATER

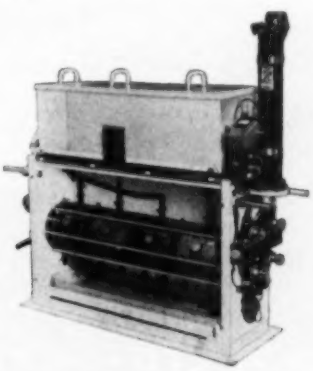
by

DISTILLATION or DEIONISATION

Consult:

LOUGHBOROUGH GLASS COMPANY Ltd.,
LOUGHBOROUGH, LEICESTERSHIRE, ENGLAND

Telephone: Loughborough 4861 Telegrams: Glass-Telex-Loughborough Telex: 34-639
Export enquiries to: Fisons Chemicals (Export) Ltd.,
Fison House, 95 Wigmore Street, London, W.1.



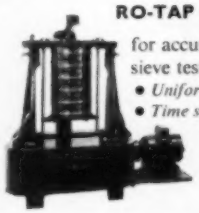
U1/2

JOHN MONCRIEFF LTD · PERTH · SCOTLAND

Grinding · Screening · Separating · Filtering

Laboratory IC equipment

RO-TAP SIEVE SHAKER



for accurate and consistent sieve testing.

- *Uniform mechanical action.*
- *Time switch control.*
- *Accommodates up to thirteen 8" dia. sieves.*

RAPID LABORATORY ELUTRIATOR

for dividing any sample of fine powder into three grades

- *Considerably quicker than older methods.*
- *Used for testing insoluble materials such as mineral ores, ceramic materials, chemicals, ochres and oxides.*
- *Special type available for treating materials soluble in water, such as cement or plaster.*

ROVAC LABORATORY FILTER

A working reproduction of the larger ROVAC machines.

- *Ideal for laboratory or pilot plant.*
- *Occupies bench or floor space of only 1ft. 3ins. × 1ft. 8ins.*
- *Has a 12ins. dia. drum.*

RAYMOND LABORATORY MILL

grinding non-abrasive materials.

- *Rotor has 8 steel swing hammers and runs at high-speed.*
- *Supplied with five perforated steel screens, of different sizes, to suit product.*
- *Easily dismantled for cleaning.*

RAYMOND LABORATORY SEPARATOR

self-contained air unit for dry particle size classification.

- *Separating chamber encloses all rotating parts.*
- *Simple to dismantle and clean. Fan and whizzer combination easily changed to suit product.*
- *Motor bearings grease-packed. No oiling required for separator parts.*

SAMPLE SPLITTER

to reduce a large sample for making sieve tests.

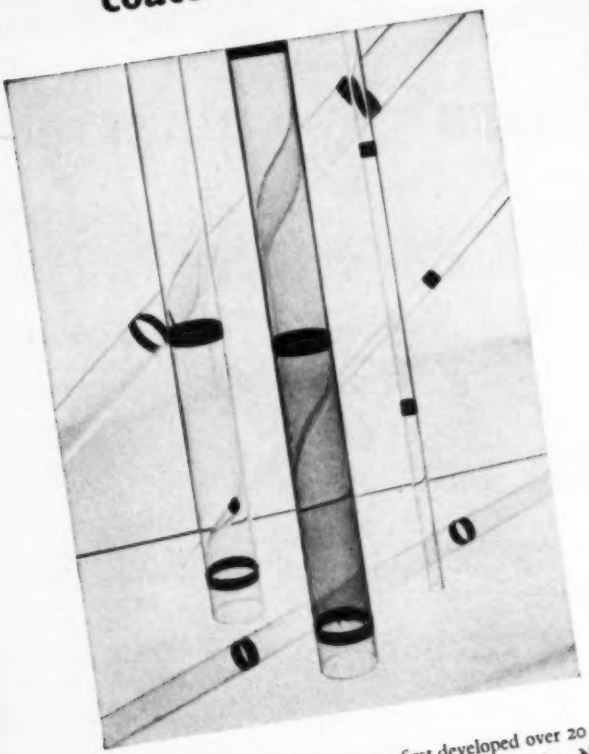
- *Made in two sizes from heavy tinned steel.*
- *No. 1: 18-¼" openings.*
- *No. 2: 16-1" openings.*
- *Both sizes discharge alternately in opposite directions.*

INTERNATIONAL COMBUSTION PRODUCTS LIMITED

LONDON OFFICE: NINETEEN WOBURN PLACE WC1 WORKS: DERBY

Member of Atomic Power Constructions Ltd., one of the British Nuclear Energy Groups

Pyrex electrically conducting coated tubing



Pyrex E.C. (Electrically Conducting) glass was first developed over 20 years ago in the Research Laboratories of the Corning Glass Works, Corning, New York, U.S.A. By combining the electrical conductivity of metals with the transparency and chemical stability of glass, a new approach to process heating was possible.

After full investigation by our Research and Development staff, this product has been manufactured and made available in this country by James A. Jobling & Co. Limited.

Description

E.C. coated tubes are made from the well-known Pyrex borosilicate heat-resisting glass. A microscopically thin transparent film of metal is permanently bonded to the outer surface of a glass tube to form an electrically conducting skin.

The tubes are manufactured in standard sizes of 19, 30 and 64mm. outside diameter and 30 and 48 inch lengths in each size. To facilitate the control of the

read the full story...

in this month's

'PYREX GLASS'

This is the 'Article of the Month' in the current issue of 'Pyrex Glass', a technical bulletin distributed free by James A. Jobling to all who are interested in the advances now being made in the development of Laboratory and Scientific glassware. 'Pyrex Glass' is published every two months, and each issue includes specially written articles.

TO RECEIVE FREE COPIES OF 'PYREX GLASS' REGULARLY

please complete this coupon and post it to us

'Pyrex' is the registered trade mark of James A. Jobling & Co. Ltd.

To The Industrial Sales Department, James A. Jobling & Co. Ltd., Wear Glass Works, Sunderland.

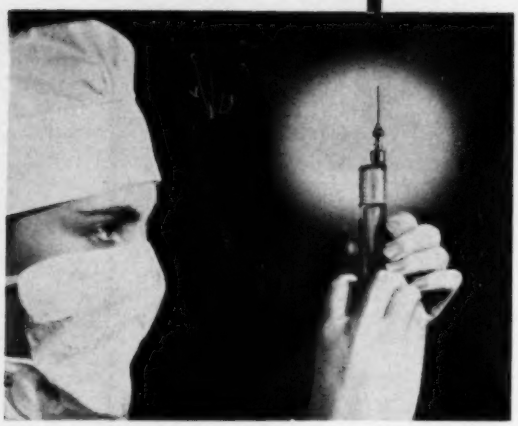
Please send ☐ copies of this issue of 'Pyrex Glass' and of all future issues, to:

name (and department).....

address .....

.....

Perfectly CLEAR!



It was left to Chance to produce the first interchangeable syringe with an *absolutely clear, unground glass barrel*. Think what this means: contents perfectly visible—every sterile syringe not just clean but *seen* to be clean—and far longer life due to reduced friction and erosive wear on the unground barrel.

The special Chance manufacturing process keeps clearances extremly fine. Any plunger fits any barrel—even after years of use. This means easy replacement at low cost.

Sizes available: 1, 2, 5, 10 and 20 ml.

Ask us to send you full particulars.

Chance THE **CLEAR BARREL** INTERCHANGEABLE SYRINGE

Sole Distributors:

SURGICAL EQUIPMENT SUPPLIES LTD.

Westfield Road, Acton, London, W.3. Telephone: ACOrn 3212-3-4

Lock INSTRUMENTATION

NUCLEAR
CHEMICAL
ELECTRONIC

Lock LABORATORY CONDUCTIVITY BRIDGE

This mains-operated instrument has a bridge frequency of 1500 c/s, and covers the very wide range of 0.05 to 1 × 10⁶ micro mhos in seven ranges.

A portable fully-transistorized bridge is also available. It covers the range of 0.5 to 1 × 10⁶ micro mhos in six ranges.

A. M. LOCK & CO. LTD.

79 UNION STREET,
OLDHAM, LANCASHIRE

Tel.: MAIN 6744

CW 7048

RANK PRECISION INDUSTRIES LIMITED

OFFER THE WIDEST RANGE OF T.V. EQUIPMENT

and the know-how that goes with it!

If you are installing a closed-circuit system or equipping a professional T.V. studio, this is your best source of equipment and information.

Experts in our Television Technical Bureau can offer you sound, practical advice, backed by the widest range of T.V. equipment available in this country.

DAGE

Rank Precision Industries have recently been appointed world-wide distributors for DAGE television equipment—a division of Thompson Ramo Wooldridge Inc. of America.

DAGE Model ETS-1. Control console for 3-camera educational system.

DAGE Model 1011. Image orthicon camera.

DAGE Model 320-B/V. Professional studio camera.

DAGE Model 70-B. completely self-contained camera with local controls.

- Unitized closed-circuit systems for industry, education, hospitals, security systems, armed forces, etc.
- Completely self-contained cameras
- Positive interlace systems
- Transistorised broadcast cameras
- Extreme environmental cameras
- Slow scan cameras
- Radiation-tested nuclear T.V. cameras
- Taylor Hobson television lenses
- Colour television equipment
- Matching audio equipment
- Monitors and large screen projectors
- Telecine

For further information, please write to:

The Professional Sales Manager, Television Department

RANK PRECISION INDUSTRIES LTD

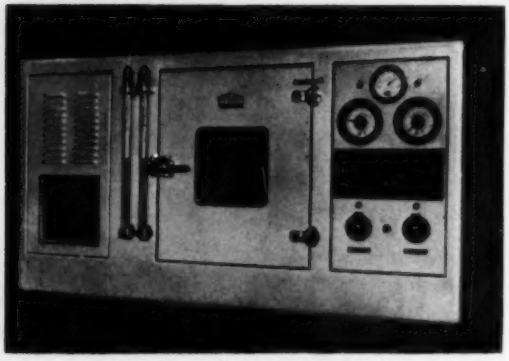
G.B-KALEE DIVISION · WOODGER ROAD · LONDON W.12 · TEL: SHEPHERDS BUSH 2050

BRANCHES: BELFAST · BIRMINGHAM · CARDIFF · GLASGOW · LEEDS · LIVERPOOL · MANCHESTER · NEWCASTLE

HEDIN

Humidity Cabinets

Ministry Approved for Climatic Testing



Catalogue No. 755 R Humidity Cabinet with automatic control and refrigeration.

Hedin Humidity Cabinets have been Ministry approved for both RCS 11 and K 114 specifications, and are available for (1) climatic testing of electrical and electronic equipment, (2) durability testing of plastics, rubber, paper, chemicals, containers, confectionery and protective coatings.

* **Construction is of stainless steel and aluminium**
* **Refrigeration available on all models**
* **Automatic control**
* **Non-standard units to special requirements**
* **Standard sizes are from 18″x18″x17″ to 6′x6′x6′**
* **Designed for easy maintenance**
* **Comprehensive auxilliary equipment available**

We shall be glad to demonstrate a cabinet in our works, or send you our leaflet L.12

HEDIN LTD. (Dept. LP) Commerce Estate, S. Woodford, London, E.18

Telephone: BUCKhurst 6601/3

WORKS: SOUTH WOODFORD AND HAINAULT, ESSEX

laboratory end runner mills

Available with four mortar sizes, 7", 10", 13" and 20" diameter, and mill supplied complete with motor and starter and with either ceramic or metal mortar and pestle which are interchangeable.

A ceramic set can be used for processing materials adversely affected by contact with metal and a metal set, either high grade cast iron or stainless steel, can be carried as a spare set for use on material for which ceramic is unsuitable.

The pestles are arranged to swing clear of or to lift out of the mortars to facilitate emptying or cleaning.

PASCALL

Write or telephone Crawley 25166 for List EN2502

THE PASCALL ENGINEERING CO LTD
GATWICK ROAD · CRAWLEY · SUSSEX

"THE BOTTOM DROPPED OUT OF MY BARGE!"

This was the problem someone recently faced. When we heard about it we were sympathetic, for the barge in question was a houseboat, and most of the owner's worldly goods had vanished in the catastrophe.

Many people would not think of looking to bacteriology for the answer. But if they did they would learn that members of the Desulphovibrio group, which are commonly present in soil and water, can corrode steel.

These anaerobic organisms, first described in 1895 by Beijerinck, are capable of reducing sulphates to sulphides. Their activities, often accompanied by the production of hydrogen sulphide, may result in the corrosion of buried iron pipes and the steel hulls of barges.

By the use of Baar's or Starkey's media they are comparatively easy to isolate as crude cultures.

Electron micrograph: desulphovibrio desulphuricans

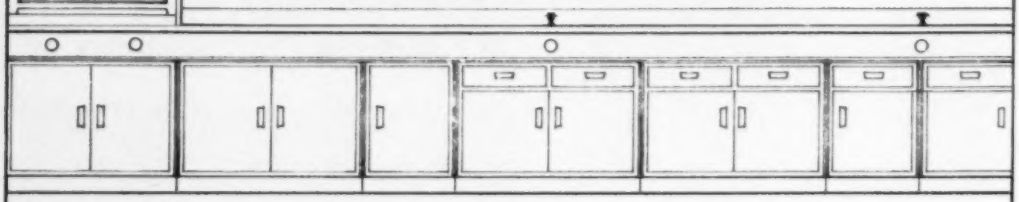
FOR PROGRESSIVE LABORATORIES OXOID **CULTURE MEDIA**

The use of Oxoid Culture Media ensures constant uniformity and quality in your laboratory technique. Absolutely reliable, quick, convenient and economical, Oxoid Culture Media are available in tablet or granular form. If you would like the manual of all Oxoid preparations, write to: The OXOID Division of OXO Ltd., Thames House, Queen Street Place, London, E.C.4 (Central 9781).

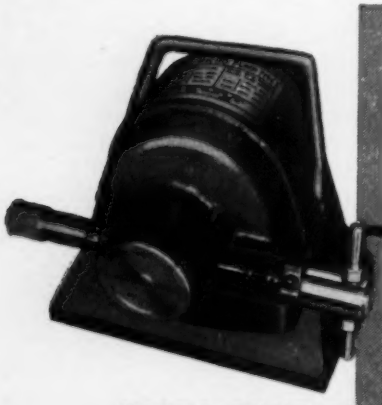
ARMSTRONGS

Armstrongs 'A' plan Laboratory Furniture is installed in Britains leading industrial and educational laboratories

Write to our Head Office at Hull for catalogues and other information



ARMSTRONGS (HULL) LTD. TERRY STREET. HULL 'PHONE 42157



MICRO PUMP TYPE S a new DCL metering pump

Safety
25/30 volts A.C. motor (plug-in transformer from any normal mains voltage)

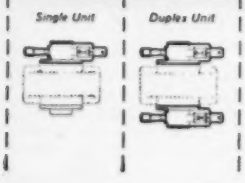
Synchronous speed
Nelson Hetropolar low speed gearless unit

Stainless steel contact
Other materials when necessary

Single or twin heads
Parts interchangeable, conversion in minutes

Six capacity ranges
Smallest from zero to 100 ccs./hr., largest from zero to 1,500 ccs./hr. controlled by micrometer adjustment.

Standard plunger or diaphragm heads

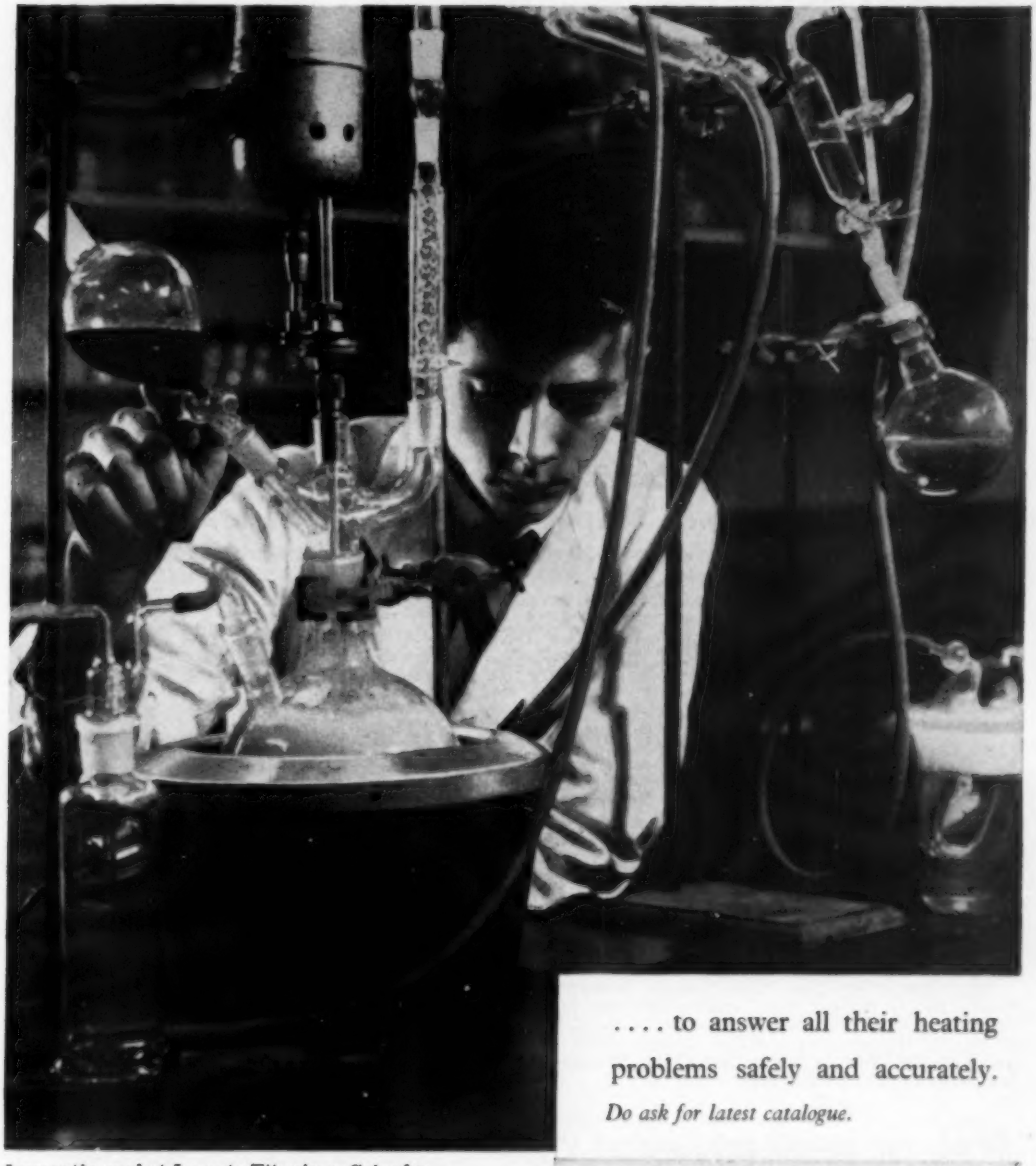


DCL *Full particulars from*

THE DISTILLERS COMPANY LIMITED
GREAT BURGH, EPSOM, SURREY
Telephone: Burgh Heath 3470

TA 4785

Chemists rely on ISOMANTLES



Isomantle used at Laporte Titanium, Grimsby

ISOPAD LTD., BARNET BY-PASS, BOREHAM WOOD, HERTS

(Telephone: ELStree 2817/9-3602)

.... to answer all their heating problems safely and accurately.

Do ask for latest catalogue.

ISOPAD ELECTRIC SURFACE HEATERS

The North of England School Furnishing Co. Ltd.

Telephone: 2708 **DARLINGTON** *Telephone:* 2708

SPECIALISTS IN LABORATORY FURNISHING

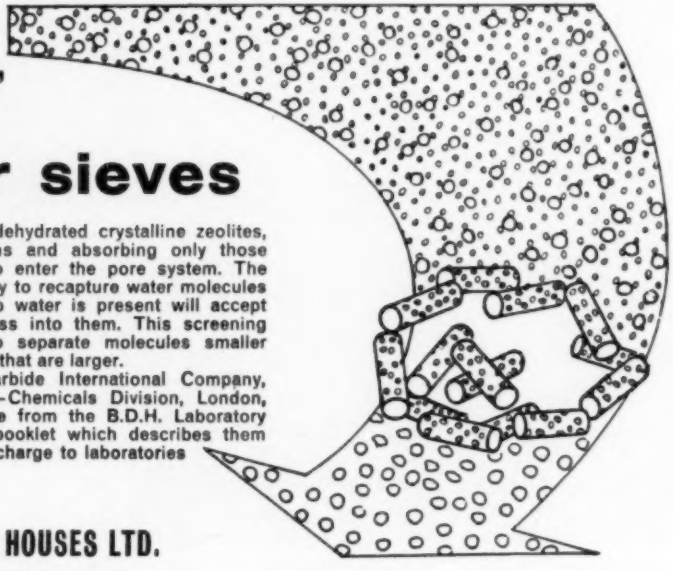
Our organisation is geared to deal with contracts from the original designing to the final fixing, including all services, wastes and extraction systems. We have been famed for Laboratory installations for over 70 years, and with the experience gained we confidently offer a service of the highest quality, whether for a simple school laboratory or for an advanced Industrial Research Laboratory.

Our Laboratory brochure, which contains particulars of recent Industrial and Hospital installations will be gladly sent on request.

London Office: 30 Bedford Row, W.C.1 ***Tel. Holborn 5221***

'UNION CARBIDE'

molecular sieves



These products are highly porous dehydrated crystalline zeolites, with pores of molecular dimensions and absorbing only those molecules that are small enough to enter the pore system. The empty cavities have a strong tendency to recapture water molecules driven off in manufacture, and if no water is present will accept any molecules small enough to pass into them. This screening action enables molecular sieves to separate molecules smaller than the size of the pores from those that are larger.

By arrangement with Union Carbide International Company, U.S.A. and Union Carbide Limited—Chemicals Division, London, they are available for laboratory use from the B.D.H. Laboratory Chemicals Division, and a B.D.H. booklet which describes them very fully will gladly be sent without charge to laboratories interested in their potential uses.

BDH **THE BRITISH DRUG HOUSES LTD.**

B.D.H. LABORATORY CHEMICALS DIVISION · POOLE · DORSET

'METROVAC' VACUUM GAUGE CONTROL UNITS

These compact and reliable units in the new Metrovac range have extensive uses in both laboratory and industrial high vacuum pumping systems.

some 'METROVAC' advantages

ECONOMY Elements can be replaced *in situ*.

STANDARD CONNECTIONS Both electrical and vacuum connections are standard for the full range of gauge heads.

STABILIZATION All control units are fully stabilized.

DIRECT READING All control units are direct reading in terms of pressure.

MOUNTING All control units are available either for bench mounting in their own box or for front of panel mounting in standard 19-inch Post Office panels. A mounting bezel, clips and cutout for a standard 19-inch panel can be supplied.

PENNING/THERMOCOUPLE COMBINED CONTROL UNIT V.C.5. Range 10^{-5}-1mm Hg.

PIRANI CONTROL UNIT V.C.6. Range 10^{-4}-1mm Hg.

THERMOCOUPLE 5-HEAD CONTROL UNIT V.C.8-5. Range 10^{-3}-1mm Hg.

For further information contact your local AEI office, or write to:

AEI

Associated Electrical Industries Ltd.

Instrumentation Division · Scientific Apparatus and X-Ray Dept.

TRAFFORD PARK, MANCHESTER 17

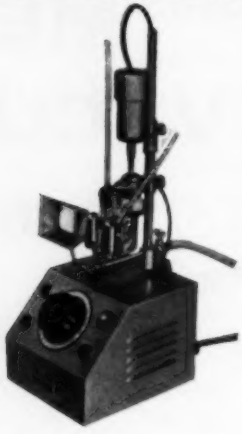
N/R004

TWO NEW RESEARCH INSTRUMENTS

(by Buchi-Flawil)

"ROTAVAPOR"

MELTING POINT APPARATUS



Please write for information to Sole U.K. Agents:

ORME SCIENTIFIC LTD
17-19 Russell Street
Manchester, 1

BEECROFT RANGE OF

PVC PLASTIC BUNGS

are being used in research departments

EVERYWHERE

write or phone for details and samples:-

BEECROFT & PARTNERS (METALLURGISTS) LTD.
RETORT WORKS, SUFFOLK HOUSE, SUFFOLK ROAD, SHEFFIELD 2.
Phone: 29686 (3 Lines). Telegrams: 'RETORT' Sheffield 2.

Thermal REFRACTORY CEMENTS AND POWDERS

Details of these special high temperature cements, and also of Thermal Fused Alumina and Fused Magnesia Powders will gladly be supplied on request.

Thermal Fused Alumina and Fused Magnesia Refractory and Insulating Cements are very simple to apply; water is the only additive necessary for mixing before application.
For base metal windings our C60 cement is ideal; for platinum windings our CC60 cement should be used. Molybdenum windings necessitate a silica-free cement, and our No. 101 cement is specially prepared for this purpose.

We also manufacture an extensive range of Vitreosil Industrial Ware

TSL

THE THERMAL SYNDICATE LTD.

P.O. Box No. 6 WALLSEND, NORTHUMBERLAND *Telephone: Wallsend 62-3242/3*
LONDON: 9 BERKELEY STREET, W.1 *Telephone: Hyde Park 1711/2*

THE NEW DRYING OVEN FROM HEARSON

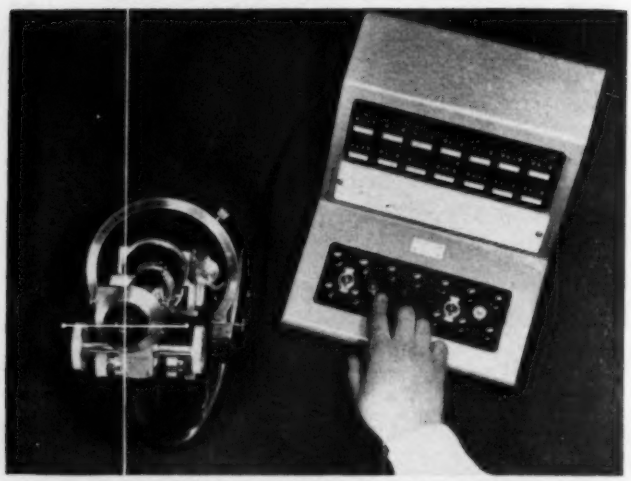
Modern laboratories demand exacting equipment and the latest Hearson drying oven gives a performance superior to the requirements of B.S.2648. Suitable for operation up to 200°C. it has a stainless-steel inner liner 15 in. wide × 15 in. deep × 18 in. high and is complete with 2 shelves. As might be expected from a company of specialists in the construction of ovens, incubators and water-baths, temperature control is beyond reproach and incorporates the new Hearson hydraulically operated thermostat. An air circulation fan is available as an optional extra. Write today for an illustrated leaflet. We will be pleased to add you to our mailing list for the receipt of regular details of new Hearson products as they are released.

H2280
Price £88. 15s. 0d.

Charles Hearson & Co. Ltd.

WILLOW WALK, BERMONDSEY, S.E.1
Telephone: Bermondsey 4494
Specialists in laboratory apparatus since 1883

SWIFT
AUTOMATIC*



POINT COUNTER

for the volumetric analysis of micro-preparations

* A single movement of one finger:—
1. Records the constituent observed on the cross-lines
2. Adds the individual count to the totaliser
3. Moves the specimen to the next observation point

Write or phone for free brochure
JAMES SWIFT & SON LTD.
113-115a Camberwell Road, London, S.E.5.
RODney 5441

PETRI DISHES

ELIMINATE TIME-WASTING WASHING, STERILIZING

The Oxoid Disposable Petri Dish is ready for instant use and can afterwards be discarded. Made of clear, moulded polystyrene, it is sterile and biologically inert as well as light in weight and virtually unbreakable.

Because of its low cost and the elimination of washing and sterilizing, Oxoid Disposable Petri Dishes offer considerable economy in use. The dishes are supplied in cartons of 200 or 500.

Full details, prices and quantity rates will gladly be sent on application.

NEW Oxoid Disposable Plastic Precipitin Tubes are now available—made from crystal-clear polystyrene, they are chemically clean and ready for immediate use. Further details supplied on request.

FOR PROGRESSIVE LABORATORIES OXOID **BACTERIOLOGICAL SERVICES**

Made for the Oxoid Division of Oxo Ltd., Thames House, Queen Street Place, London E.C.4. Telephone: CENtral 9761

Astell low temperature incubator

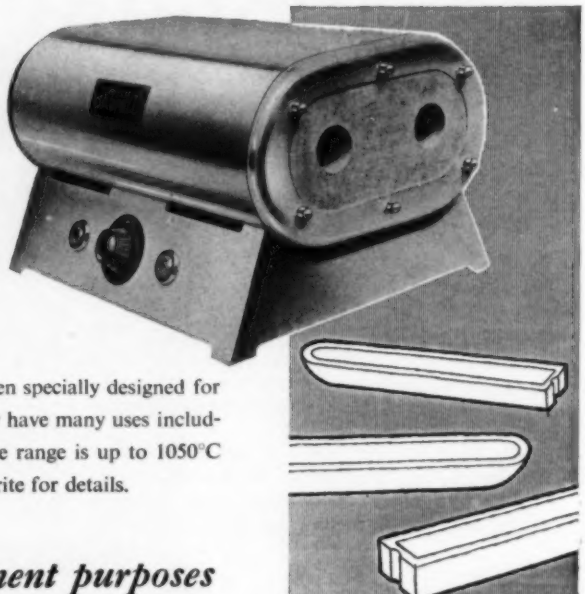
For many purposes incubation at temperatures below ambient is essential. Undesirable temperature variation within the incubator itself is entirely avoided by the Astell system of fan-induced air circulation. Automatic and accurate control of incubation at any temperature in the range 5–40°C is now possible with the Astell low temperature incubators. These are standard domestic refrigerators fitted with auxiliary heater, circulation fan and a sensitive indicating thermostat.

172 BROWNHILL ROAD · CATFORD · LONDON SE6 · HITher Green 4814/5

Astell

Laboratory Service Co Ltd

Wild-Barfield muffles for a better job



Wild-Barfield laboratory tube muffles have been specially designed for use in analytical and works laboratories. They have many uses including critical point determinations. Temperature range is up to 1050°C (1922°F). Models are available from stock. Write for details.

ELECTRIC WILD BARFIELD FURNACES *for* all *heat treatment purposes*

WILD-BARFIELD ELECTRIC FURNACES LIMITED

ELECFURN WORKS · OTTERSPOOL WAY · WATFORD BY-PASS · WATFORD · HERTS. Tel: Watford 28091 (9 lines) Grams: Elecfurn, Watford. WB90

Progress
in Electronics

Developing our resources and service to meet the needs of today, we are now moving into the field of electronics and can offer X-Y recorders, digital volt meters, ultrasonic mixers and other control equipment.

Scientific Furnishings Ltd

X-Y RECORDER

Main distributors for Quickfit & Quartz, E-Mil, Pyrex, etc., etc.

Advisory and drawing office service for laboratory furniture and installations.

Sole agents for metallurgical and electronic equipment.

SCIENTIFIC FURNISHINGS LTD
POYNTON CHESHIRE
Telephone: POYnton 2815 & 2776

Southern Branch:
West Hampnett Road, Chichester, Sussex.
Telephone: Chichester 4703

LABORATORY APPARATUS

ROYAL HORTICULTURAL SOCIETY'S NEW

Photographs of some of the exhibits at the 1960 Exhibition

★ DON'T MISS THIS OUTSTANDING EVENT!

& MATERIALS EXHIBITION

HALL WESTMINSTER LONDON S.W.1

A SPECIALISED EXHIBITION

Presented for the second year in succession to enable manufacturers and suppliers to show new equipment and materials which are in actual production, fully tested and readily available. Only apparatus and materials specifically designed for use in laboratories of all kinds are to be seen.

'Laboratory Practice' through its Scientific Advisory Committee, is again arranging an important programme of twelve lectures covering recent advances in laboratory techniques. Each lecture will be given by a specialist in the subject, under the chairmanship of an acknowledged authority in that field. The programme will be published in a later issue of this journal.

DO NOT MISS THIS EXHIBITION—THE NEXT WILL NOT BE HELD UNTIL 1963

LABORATORY APPARATUS & MATERIALS EXHIBITION

JUNE

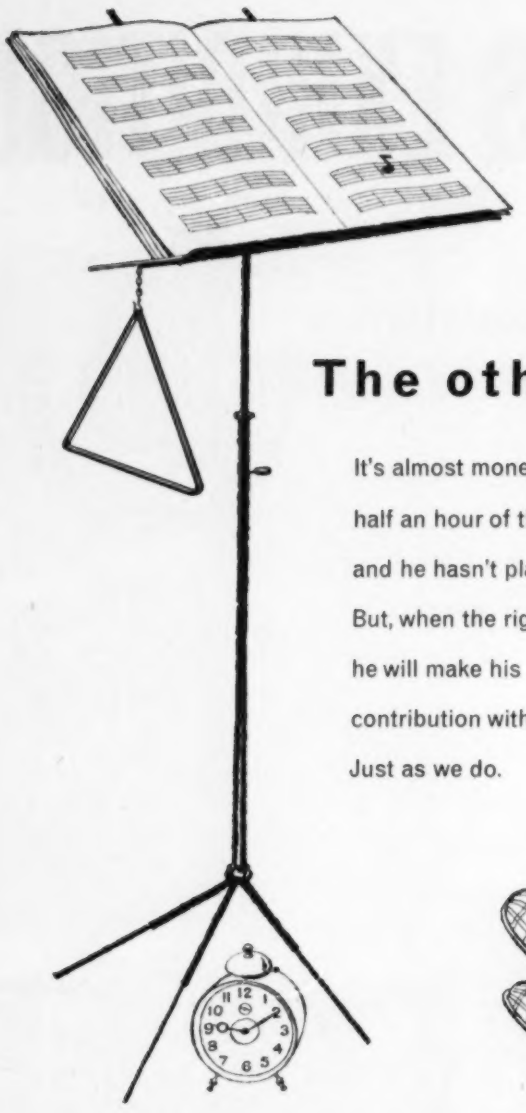
19, 20, 21, 22

1961

Sponsored by
LABORATORY PRACTICE

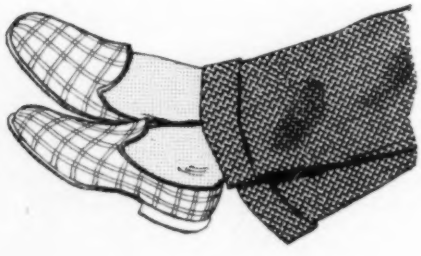
Supported by the
BRITISH LABORATORY WARE ASSOCIATION LTD.

Organised by **U.T.P. Exhibitions Ltd., 9 GOUGH SQUARE, FLEET STREET, LONDON, E.C.4**
Phone: FLEET STREET 3172



The other man's job—

It's almost money for jam—
half an hour of the symphony gone
and he hasn't played a note.
But, when the right moment comes
he will make his
contribution with precision.
Just as we do.



Griffin

GRIFFIN & GEORGE

The Laboratory Furnishers

GRIFFIN & GEORGE (SALES) LIMITED, EALING ROAD, ALPERTON, WEMBLEY, MIDDLESEX. (PER 3344)

A member of the Griffin and George group of companies

LONDON · BIRMINGHAM · MANCHESTER · NEWCASTLE UPON TYNE · GLASGOW

LABORATORY PRACTICE

RESEARCH · CONTROL · TEACHING

Vol. 10 FEBRUARY 1961 No. 2

Scientific Advisory Committee

Professor Sir Charles Dodds, M.V.O., D.Sc., M.D., F.R.C.P., F.R.S.
Professor George I. Finch, M.B.E., D.Tech.Chem., F.Inst.P., F.R.S.
Edward Hindle, M.A., Sc.D., Ph.D., F.R.S.
Professor H. D. Kay, C.B.E., D.Sc., Ph.D., F.R.S.
Professor A. A. Miles, C.B.E., M.A., M.D., F.R.C.P.
Sir Robert Robinson, O.M., M.A., D.Sc., Sc.D., LL.D., F.R.I.C., F.R.S.
Professor S. Tolansky, D.Sc., Ph.D., D.I.C., F.R.S.
J. G. Davis, D.Sc., Ph.D., F.R.I.C.

CONTENTS

Page

EDITORIAL 87

ARTICLES:

MAGNETOCHEMISTRY, Part I, *by A. Earnshaw* . . 89
ELECTRONICS FOR BIOLOGISTS, Part II, *by G. C. Ware* 92
VARIATIONS AND ERRORS IN EXPERIMENTAL INVESTIGATIONS, Part I, *by S. Lewin* . . . 99

APPARATUS AND DEVICES:

STOP-ACTION CONTROL OF DELIVERY FROM BURETTES, *by M. A. Fill and E. H. Wren* . . . 102
A CONSTANT PRESSURE HEAD APPARATUS, *by C. C. Harris* 105
A SIMPLE ELUTRIATION SEPARATOR FOR MIXED BED ION EXCHANGE RESINS, *by D. H. Constable* . 106
AN APPARATUS FOR THE DETERMINATION OF VOLATILE ACIDITY, *by B. D. Powell* . . . 107

HUMIDITY EFFECTS ON MICROBALANCES . . 108
BOOK REVIEWS 109
LABORATORY NOTE-BOOK 112
NEWS FROM THE BRITISH ASSOCIATION OF CHEMISTS 113
LABORATORY EQUIPMENT AND APPLIANCES . 114
NEWS 115
CATALOGUES, BROCHURES & LEAFLETS . . 116
MEETINGS FOR THE MONTH 116

Annual Subscription £2 5s. 0d., postage free (U.K. only), $7 (U.S. and Canada), £2 10s. 0d. (other countries). Single copies 4 shillings

UNITED TRADE PRESS, LTD.

9, Gough Square, Fleet Street, London, E.C.4.

Telephone: Fleet Street 3172 *Telegrams:* Markeba, London

EDITORIAL

A Scientist's Views on Salesmanship

THERE ARE three essentials to a successful business—to make the sort of goods the customer wants, to make them of good quality, and to sell them. The last is not the least important, and many otherwise good firms have failed because of shortcomings in this respect. Salesmanship has a highly developed and set pattern today, but scientific apparatus is almost unique in that nearly all the buyers have an expert knowledge of what they are buying. The man who buys a car, a television set or a refrigerator may or may not have an expert knowledge of his purchase, but the man who buys a pH meter, a balance, an autoclave or a microscope usually has such expert knowledge. He has usually decided to buy before the contact with the salesman is made so that the most difficult part of the selling process is over. The prime concern of the representative of scientific equipment firms is not to convince the customer that he ought to buy apparatus X, but that he ought to buy apparatus X made by firm Y.

It is of interest to consider how selling methods in this industry differ from those for ordinary consumer goods. There are five main methods whereby scientists can obtain information about scientific apparatus—through advertisements, by circulars, through reports in certain journals, through calls by the representatives of firms, and from other scientists using the same types of apparatus. As in all industries, it is probable that the last carries most weight. In other words, it is performance which really sells in the long run, but scientists in isolated laboratories may not have the opportunity to discuss the merits of various incubators or muffle furnaces with another scientist, and so they have to rely on other means. The only other unbiased method is to study test reports made by independent laboratories. As far as we know, this journal is the only medium for publishing such reports.

The remaining three methods are naturally biased but manufacturers do not always use these to the best advantage. A considerable part of most scientific journals is devoted to the advertising of apparatus and chemicals. Such advertisements serve to remind us that certain firms make certain apparatus, but in practice the

potential purchaser knows that firms A, B, C and D make balances, and firms E, F, G and H make microscopes. What the buyer wants to know is the price, specification and performance, and few advertisements give this information. Ordinary sales talk cuts no ice with the scientist—it may even make him suspicious. It is true that prices are subject to increase without notice, but we are used to this today. Basic information about construction, performance and price is more useful to the scientist than a pretty picture and sales talk.

Like medical practitioners, scientists today receive vast amounts of circulars advertising apparatus, materials and books. The method of address often indicates which scientific society list of members the manufacturers have used. One methodical recipient calculated that he received several hundredweight every year, and pointed out that the user has to pay for all this. We have often received two or more identical circulars together as we are a member of several societies. It is probable that 90 per cent of these circulars go straight into the waste box. The 10 per cent which is read may only annoy if the basic information listed above is not given.

We have a very high opinion of the calibre of the representatives of scientific apparatus firms today. They are sometimes science graduates, know their job and are courteous and efficient. Gone are the days when they tended to be one of two types. We had the smart, ingratiating type who turned up in an expensive car with an expensive lady passenger, knew very little about the scientific side of his job, but hoped to impress his customers with his public school (left suddenly) and his university (failed to obtain a degree). The other type might be described as the old-fashioned commercial traveller. We recall one gentleman who had no scientific knowledge, but came along regularly at the same time with black bag, black hat, black coat and black notebook. He had no sales talk. He opened his notebook, licked his pencil and waited. He got the orders. The service which representatives give today is, with the occasional exception, excellent. The rest of their organizations, however, is not always of the same standard.

While stressing that the incidents now given are isolated, it may be of some help to manufacturers if we mention some of the unsatisfactory features of the apparatus supply services today. The office work is sometimes very poor, and we get the impression that enquiries are dealt with by juniors who have no technical knowledge and do not bother to seek it when necessary. On one occasion a research worker wrote to a firm named in an official document as being the manufacturer of a material specified for a certain official test. He received a letter denying that the firm made such a material. On another occasion Prof. A. received a circular inviting him to enquire for particulars of a certain material. He immediately filled in and returned the card. Not hearing anything within a week or two he forgot all about the matter until some three months later he received a circular letter beginning 'Dear Prof. X, We thank you for your recent enquiry'.

Another important aspect is time of delivery. We cannot be surprised if a delivery time of three or six months is quoted for a special and unusual apparatus, but there is no excuse for a large firm to take six months to deliver an ordinary piece of apparatus which is in use every day. Recently we heard of one case where such an apparatus was delivered in three instalments over five months and then was still incomplete, and the parts could not be fitted together.

Another feature about which firms should be careful is claims on cost which omit rather expensive charges. For example, a representative may claim that an equipment costing £200 will last for 20 years, so that the cost is only £10 a year. Only after the decision to buy is the purchaser advised to have a maintenance service at £10 a year, so that the real total cost is not £200 but £400. Similarly claims may be made for an apparatus for the preparation of a material in everyday use. Skilled salesmanship may suggest that the new apparatus halves the cost of production by the older method, but only after ordering does the purchaser realize that the *total* cost of both apparatus and necessary materials, etc. is at least as high if not higher than that of the method he is abandoning.

With the general high quality of scientific apparatus in this country today, service becomes the predominant aspect, and firms will flourish or fail according to the quality of their service. All scientists realize that everything wears out in time and that maintenance and repairs are necessary. However the charges should be reasonable. If a firm charges nearly £10 for a repair job requiring one man for a couple of hours and quite inexpensive materials, it is unlikely to get repeat orders. Too much of this will only encourage laboratories to organize their own maintenance and repair schemes. Are there any 'Do it yourself' kits in the laboratory equipment world?

British scientific apparatus is second to none, and it is a pity that the service is not always of the same quality. The vast majority provide not only excellent apparatus but also excellent service, and telephone calls and letters receive immediate attention. They put themselves out to serve their customers and as a result retain their customers. Firms who are inefficient in this respect may not get a second chance.

LABORATORY APPARATUS AND MATERIALS EXHIBITION

Venue: Royal Horticultural Society's New Hall, Westminster, S.W.1.

Date: June 19 to 22, 1961.

Make a diary note NOW

MAGNETOCHEMISTRY

A. Earnshaw, Ph.D.

*Battersea College of Technology, London, S.W.*11

PART I—THEORY AND APPLICATIONS

MAGNETIC measurements are being used by chemists to an increasing extent, particularly in the field of transition metal chemistry, and a magnetic balance which can be used to measure the magnetic moment of a compound, at least at room temperature, is now essential in any well-equipped inorganic laboratory. In the following articles an attempt will be made to describe briefly the theory and uses of magnetic measurements and the construction of a simple Gouy balance for use at room temperature, and also of a similar type of balance adapted to allow measurements to be made over a range of temperatures. For a more comprehensive account of the theory the reader should consult any of the standard works available.[1,3,4].

Origin of Magnetism

All substances are affected by a magnetic field. The magnetic lines of force are either converged or diverged within the substance which, if the field is not homogeneous, results in the substance being either attracted to, or repelled from, the regions of strongest field. The former behaviour is classified as paramagnetic and the latter as diamagnetic and all substances fall into one or other type. The phenomena arises from the properties of the electrons within the atom. For the present purpose it is sufficient to consider such an electron as behaving simultaneously as a moving charge, that is to say as an electric current, and, by virtue of its so-called 'spin', as a small bar magnet. It follows that when a substance is placed in a magnetic field there will be two effects on the electrons within the atoms.

(*a*) By virtue of the similarity to an electric current, Lenz's Law will be obeyed and the current will change in a manner such as to set up an associated field opposing the applied field. This is diamagnetic behaviour and is present in all substances whether or not it is swamped by a larger paramagnetic effect.

(*b*) By virtue of the similarity to a bar magnet, the applied field will be reinforced by alignment of the small magnetic moments associated with the electrons' This is paramagnetic behaviour. However the paramagnetism of electrons within an atom is restricted because of their tendency to associate in 'pairs', i.e. with their magnetic moments aligned in mutual opposition. Thus only atoms or ions containing 'unpaired' electrons have a resultant magnetic moment* which is made up of the moments of the 'unpaired. electrons within. This is why the study of paramagnetism is largely restricted to transition metal chemistry.

Quantitatively the magnetic properties of a substance in a magnetic field are conveniently described by the constants derived from the expression:

$$B = H + 4\pi I$$

where B is the magnetic induction, or the density of lines of force within the specimen. H is the applied field and I is the intensity of magnetization.

$$\frac{B}{H} = 1 + 4\pi\frac{I}{H}$$

$$\text{or } \mu = 1 + 4\pi\varkappa$$

where μ is the magnetic permeability and $\varkappa$ is the susceptibility per unit volume.

More convenient than $\varkappa$ is χ, the susceptibility per g. $\chi = \varkappa \div$ density.

Multiplying by the molecular weight gives χ_M the molar susceptibility, and atomic and ionic susceptibilities can be similarly defined.

For a paramagnetic material I, $\varkappa$ and χ are positive while for a diamagnetic material they are negative.

If field strengths are measured in oersteds, and densities in g. per c.c., the numerical magnitude of χ is 0 to -10^{-6} for diamagnetic materials and 0 to $+10^{-4}$ for normal paramagnetic materials.

In normal paramagnetism the unpaired electrons within an atom combine magnetically to give a resultant magnetic moment for the atom, but the paramagnetic atoms or ions are completely independent of each other. This is the case for instance in many complexes of transition metals where the metal ions are shielded from each other by large diamagnetic co-ordinated groups, and the complex is said to be 'magnetically dilute'. However when this condition does not occur, and the compound is 'magnetically concentrated', the paramagnetic ions exert an influence on each other causing a degree of permanent alignment. If the atomic magnetic moments are aligned parallel a large increase in χ occurs (up to $+10^4$) and the compound is said to be ferromagnetic, while if the moments are aligned antiparallel χ is reduced and the compound is antiferromagnetic.

Ferro- and antiferro-magnetism are evidently subdivisions of paramagnetism but are in general of more interest to the physicist than to the chemist and, since diamagnetism is usually of interest only in that it signifies the absence of unpaired electrons, the discussion will now be confined to a consideration of normal paramagnetism.

*Magnetic moment is denoted by μ, the symbol also used for magnetic permeability. The confusion is unfortunate.

Effect of Temperature on χ

$\varkappa$ and χ are measures of the ability of the substance to converge the lines of force of an applied field. An alternative point of view is that they are measures of the extent to which the 'atomic bar magnets' align themselves in the direction of the applied field.

It follows that a rise in temperature, which increases thermal agitation of the atoms and molecules, and will thus tend to reduce the alignment of the atoms, will cause a reduction in the value of χ. This is expressed in the well known Curie Law

$$\chi = \frac{C}{T}$$

where C is the Curie constant and T the temperature in degrees absolute.

In practice this law is usually not an accurate description of the behaviour and a correction is applied in the Curie-Weiss Law

$$\chi = \frac{C}{(T + \theta)}$$

where θ is the Curie-Weiss constant. Now the magnetic moment, μ, of an atom or ion is a measure of the strength of the atomic bar magnets irrespective of whether they are aligned by an external field or not, and as such should ideally be independent of changes in temperature. Assuming this, it can be shown that $\mu = 2{\cdot}84\sqrt{\chi_A \times T}$ where μ is measured in Bohr Magnetons, and will obviously be independent of temperature if the Curie Law is obeyed. However, since as mentioned above, this is frequently not the case it is quite common practice to include the Curie-Weiss constant, $\mu = 2{\cdot}84\sqrt{\chi_A \times (T + \theta)}$, but this practice is rarely justifiable theoretically and it is better to work out μ_{eff} the 'effective magnetic moment' from the previous equation and to state the temperature at which it was measured.

Relationship between μ and the Number of Unpaired Electrons

For a chemist the object in making a magnetic measurement is to obtain a value for μ and from this to deduce n, the number of unpaired electrons in a particular compound. To date this process has been most extensively applied to co-ordination compounds, or complexes, of first row transition elements where, with some notable exceptions, the relationship is approximately

$$\mu = \sqrt{n(n+2)}$$

Thus for $n = 1$ $\mu = \sqrt{3}$ $= 1{\cdot}73$ B.M.
$n = 2$ $\mu = \sqrt{8}$ $= 2{\cdot}83$ B.M.
$n = 3$ $\mu = \sqrt{15}$ $= 3{\cdot}87$ B.M.
$n = 4$ $\mu = \sqrt{24}$ $= 4{\cdot}90$ B.M.
$n = 5$ $\mu = \sqrt{35}$ $= 5{\cdot}92$ B.M.

The corresponding relationships for the second and third row transition elements and for the inner transitional elements, or rare earths, are not so straightforward. The cause of this lies in the way in which the moments associated with the individual unpaired electrons combine together within an atom to give a resultant moment. This is dependent on the energy states of the atom which in turn are dependent on the nuclear charge and electronic configuration.

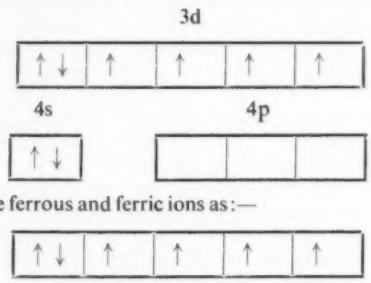
Once n has been determined it is of great value in elucidating problems of valency and bond type, and hence of stereochemistry.

n Related to Valency and Bond Type

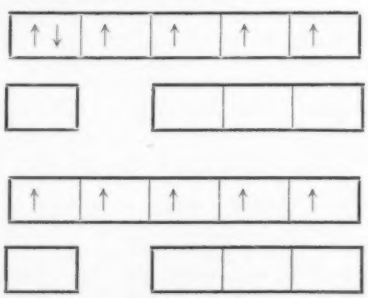
A convenient, if hypothetical, way of considering the formation of a co-ordination compound is that of a metal ion in its free state being approached from the appropriate directions by the co-ordinating groups, or ligands, with the donor atoms pointing towards it. The electron pairs from each donor atom then enter suitable electronic orbitals of the metal ion. These orbitals may or may not contain electrons of the metal ion, but, if they do, these must first be transferred to other orbitals to allow co-ordination to take place. This transference may take the form of promotion to orbitals of a higher energy or, where unpaired electrons are concerned, they may 'pair up' with electrons in other orbitals.

It is, as Pauling showed[2], the orbitals occupied by the donated electrons which determine the stereochemistry of the molecule. Thus sp^3d^2 or d^2sp^3 bonding implies an octahedral configuration, sp^3 tetrahedral, and dsp^2 planar, to mention the more common types. As the use of these orbitals affects the number of unpaired electrons on the metal ion the magnetic moment is a potential indication of the type of bonding taking place. But perhaps a few examples will clarify the point.

The configuration of the valency electrons of, say, iron are commonly represented diagramatically as:



and the ferrous and ferric ions as:—



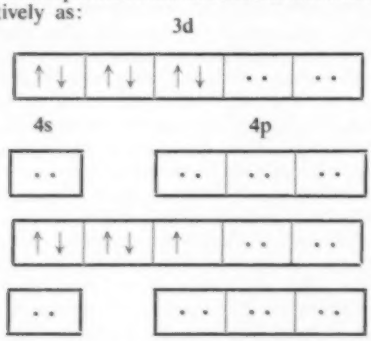
and

It can be seen that the ferrous ion has four unpaired electrons and the ferric five. Simple theory, as has been mentioned, predicts moments of 4·90 B.M. and 5·92 B.M. respectively for these ions. In practice the moment

of the ferrous ion is usually somewhat higher but, provided the compounds are magnetically dilute, they are quite distinguishable and the valency can readily be identified in this way.

Usually the metal is not present as the simple ion but in a co-ordinated form when some of the orbitals are occupied by bonding electrons. If the complex is octahedral the six pairs of donated electrons can be accommodated either, two pairs in the 3d, one pair in the 4s, and three pairs in the 4p orbitals, or one pair in the 4s, three pairs in the 4p and two pairs in the 4d. These are the d^2sp^3 and sp^3d^2 configurations already mentioned . It is evident that the latter configuration need cause no change in the electronic arrangement of either the ferrous or the ferric ions and the moments of such complexes are essentially the same as for the simple ions.

However, in the case of d^2sp^3 complexes of iron, two of the 3d orbitals must first be vacated before bonding can take place and these electrons in fact 'pair up' with electrons in the remaining 3d orbitals. This can be represented for ferrous and ferric complexes respectively as:

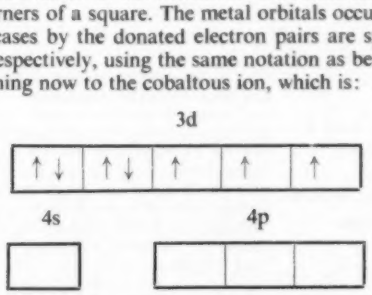


where • • represents a pair of bonding electrons.

The situation now is that the ferrous complex has no unpaired electrons and is diamagnetic, while the ferric complex has a single unpaired electron with a moment which is in fact generally somewhat higher than 1·73 B.M.

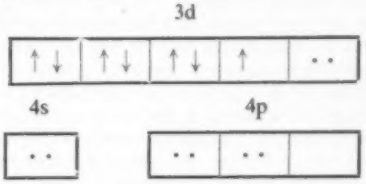
Four co-ordinated complexes are of two types. The four ligands can be arranged symmetrically around the metal ion either at the corners of a tetrahedron or at the corners of a square. The metal orbitals occupied in these cases by the donated electron pairs are sp^3 and dsp^2 respectively, using the same notation as before.

Turning now to the cobaltous ion, which is:



†d^2sp^3 complexes are usually termed either 'spin paired', 'inner orbital' or 'covalent', while sp^3d^2 are similarly termed 'spin free', 'outer orbital' or 'ionic' depending on the inclination of the particular author.

it can be seen that the tetrahedral, sp^3, configuration will not change this arrangement. However, for reasons which are well understood but which it is beyond the scope of this article to deal with, the observed moments are in excess of the expected value of 3·87 B.M. being in the range of 4·3 to 4·7 B.M. These values are nevertheless quite unambiguously distinguishable from the moments of square planar complexes for in this case a 3d orbital is used for bonding, resulting in the arrangement:



which has only one unpaired electron giving rise to moments in the range 2·1 to 2·9 B.M.

Table I gives examples of the moments found in the complexes of some of the first row transition elements.

TABLE I

Ion	*Bond Type*	*n*	*Experimental Moment*	*Example*
Cr^{3+}	d^2sp^3	3	3·7 to 3·9	$[Cr(NH_3)_6]I_3$
Mn^{2+}	sp^3d^2	5	5·7 to 6·1	$[Mn(NH_3)_6]Br_2$
	d^2sp^3	1	1·8 to 2·1	$K_4[Mn(CN)_6]$
	sp^3	5	5·7 to 6·0	$[Mn(C_5H_5N)_4]Br_2$
Fe^{3+}	sp^3d^2	5	5·7 to 6·0	K_3FeF_6
	d^2sp^3	1	2·0 to 2·5	$K_3[Fe(CN)_6]$
Fe^{2+}	sp^3d^2	4	5·1 to 5·7	$[Fe(NH_3)_6]Cl_2$
	d^2sp^3	0	diamag.	$K_4[Fe(CN)_6]$
Co^{2+}	sp^3d^2	3	4·8 to 5·2	$[Co(NH_3)_6]Cl_2$
	dsp^2	1	2·1 to 2·9	Co(phthalocyanine)
Ni^{2+}	sp^3	2	2·6 to 3·2	$[Ni(NH_3)_4]SO_4$

Although this is no more than the briefest outline of the subject it is sufficient to illustrate the utility of magnetic measurements as a routine tool in the investigation of transition metal complexes. If the condition of magnetic dilution is satisfied a measurement at a single temperature may suffice, but it is undoubtedly more satisfactory if χ is measured over a range of temperature, since only in this way can deviations from ideality be detected with certainty. Indeed the exact measurement of the deviation itself may be of fundamental importance in which case temperature studies are quite indispensable.

REFERENCES

[1]Nyholm, R. S. (1956). 10e Conseil de l'Institut International, Solvay, Brussels.
[2]Pauling, L. (1940). 'Nature of the Chemical Bond', Cornell Univ. Press, New York.
[3]Selwood, P. W. (1956). 'Magnetochemistry', Interscience, New York.
[4]Stoner, E. G. (1926). 'Magnetism and Atomic Structure,' Methuen, London.

ELECTRONICS FOR BIOLOGISTS

by G. C. Ware

Department of Bacteriology, University of Bristol

PART II

Alternating Current

In alternating current the voltage is continually rising, falling, then becoming negative, rising and again falling, at regular intervals (Fig. 5). A wave of this shape is obtained when the function $Y = \sin X$ is plotted as a graph, and is known as a *sine wave*; sound waves and their electrical equivalents have the same general shape. Such a wave can be divided into completely similar sections each being called a cycle. Alternating voltages are characterized by their *frequency*, measured in *cycles* per second, kilocycles per sec. (1Kc/s. = 1,000 c/s.) or megacycles per sec. (1Mc/s. = 10^6c/s.). As the voltage of an alternating current is continually changing it is usually expressed, either as the peak voltage measured from the zero axis to either peak, or (as the peak voltage is a little unfair representing the voltage for only a short portion of the time) as the root mean square (R.M.S.) voltage, which is a fixed proportion, roughly seven-tenths, of the peak voltage. Mains electricity in this country is alternating current with a frequency of 50 c/s. an R.M.S. voltage between 200 V. and 250 V. and peak voltage between 280 V. and 350 V.

The C.R.O.

The cathode ray oscilloscope (C.R.O.) is such an important and useful piece of equipment that a brief description of its use will help the explanation of certain other electrical phenomena. In the C.R.O. a beam of electrons in the cathode ray tube is focused to form a small visible spot on the screen. The spot can be deflected from its central position on the screen by application of a voltage to the deflecting plates of the cathode ray tube. Switches are usually provided so that voltages may be applied directly to the plates, or through voltage amplifiers which increase the spot deflection produced by a given voltage. C.R.O. amplifiers are basically of two types, one capable of handling varying signals only, and the other also able to amplify steady voltages. In biological applications the latter type is often more useful.

The C.R.O. has a *time-base* producing voltages which can be connected to the horizontal (X) deflection plates of the cathode ray tube causing the spot to travel repeatedly from the left to the right of the screen at a steady, but adjustable velocity. Because of the persistence of fluorescence of the screen, and persistence of vision in the eye, such a scan by the spot appears as a line on the screen. At speeds below 10 cm./sec. the eye is able to follow the spot movement across the screen. Application of any voltage to the vertical (Y) deflection plates will cause the travelling spot to be deflected from its straight course. Thus if a battery were connected to the Y plates when the spot had travelled half way across the screen, a step-like trace would be produced. (Fig. 6a). If the voltage were applied gradually through a potentiometer then the deflection would be gradual. (Fig. 6b). Reversal of the battery connections would result in reversal of the direction of deflection. Using conventional algebraic nomenclature we will regard upward deflection of the spot trace as the result of application of a positive voltage to the C.R.O. As the vertical deflection of the beam is nearly proportional to the applied voltage the C.R.O. may be used as a voltmeter. (Fig. 7). It cannot be used to measure current directly but by observing the voltage developed across a known resistance in a circuit the current flowing may be calculated. ($I = \frac{E}{R}$).

Application of an alternating current would result in the production of a sine wave if the time of scan was longer than the time of one cycle (Fig. 8a). If the scan time were short compared to one cycle, the picture would

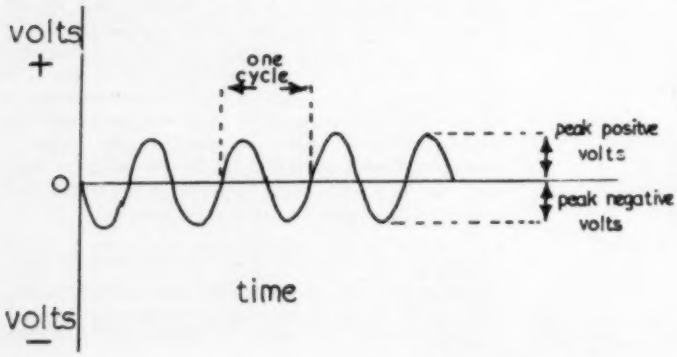


Fig. 5. Alternating current, sound waves and their electrical equivalents occur as *sine waves*. Each symmetrical section of the wave is termed a cycle and the wave can be characterized by its frequency expressed in cycles per sec. The height of the waveform from negative peak to positive peak is equal to twice the peak voltage. The RMS voltage is 0·707 times the peak voltage.

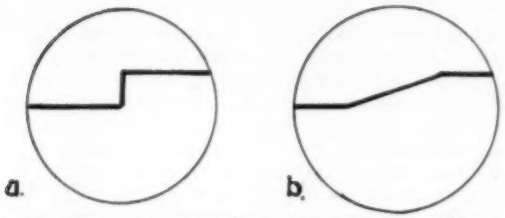


Fig. 6. The appearance of an oscilloscope trace when a positive voltage is (*a*) suddenly and (*b*) gradually applied to the Y plates.

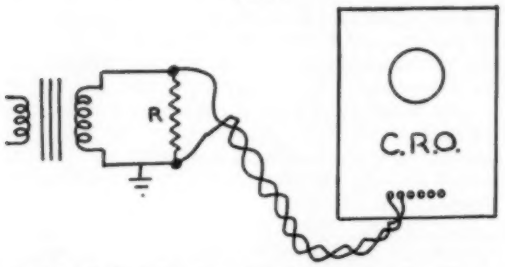


Fig. 7. By displaying a voltage, here derived from a transformer, on the C.R.O., measurements of peak voltage may be made. If the value of R is known the current flowing in the circuit may also be deduced.

represent several consecutive sections of the wave superimposed (Fig. 8b and 8c). The latter condition is of little use and scan frequencies lower than the applied or signal frequency must be used.

Although the C.R.O. can be used to observe random and single events it is often difficult to retain mentally a clear impression of a single trace and a photograph is usually essential. For regularly spaced repetitive events the C.R.O. is specially useful, for by diverting some of the signal to the time base, *synchronization* may be achieved with each trace exactly following the course of the previous one producing a steady picture. Some C.R.O.'s are provided with two or more beams so that different signals may be simultaneously displayed. Both beams however usually operate from a common time base. Familiarity with the C.R.O. may only be achieved by experiment and it is well worth the time and trouble to acquire a C.R.O. and its instruction book for an afternoon's education and entertainment! An understanding of its working, will suggest many varied applications from time to time, ranging from the observation of heart beats to electronic fault finding.

Hum

Alternating current radiates an electrical field of the same frequency and because of the almost universal distribution of mains wiring it is impossible to escape from the influence of those fields and any wire is liable to have small a.c. voltages induced in it. For example, if a few feet of wire are connected to the Y amplifier of a C.R.O. and allowed to hang over the back of a chair or table a 50 c/s. wave will be produced on the screen. Similar voltages are produced in the human body and may be detected by touching the A amplifier terminal of the C.R.O. These mains induced signals may be several volts in magnitude. Wires in electronic equipment also pick up these signals which, when amplified and connected to a loud speaker, produce a characteristic hum. One of the chief difficulties in the construction of electronic equipment is the avoidance of hum.

Measurement of D.C. Voltage and Current

Nearly all voltmeters and ammeters used in electronic apparatus are of the *moving coil* type. These consist of a small coil of fine wire, supported on pivots between the poles of a magnet (Fig. 9). Current passing through the coil causes the coil to rotate in the magnetic field against the force of two hair springs holding the coil. The greater the current which flows the greater is the rotation. As the direction of the current flow determines the direction of rotation, moving coil meters cannot be used on alternating currents and on direct currents correct polarity (direction of current flow) must be observed.

Meters of this type can be made which give full scale

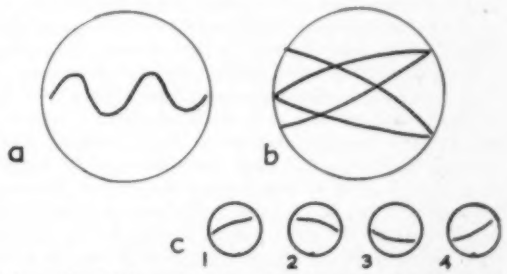


Fig. 8. To obtain a sine wave display on a C.R.O. the scan frequency must be less than the frequency of the applied voltage (*a*). If it is greater the wave will be broken into several scans (C_1-C_4) and appear as a complex waveform.

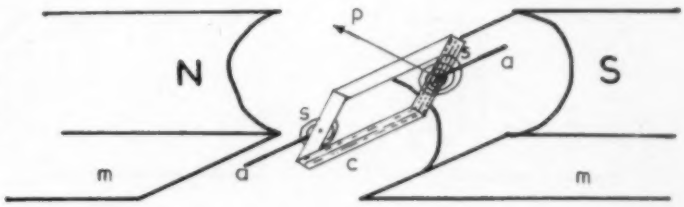


Fig. 9. Expanded diagram of a moving coil meter. Current is usually fed to the coil through the hair springs. The pivots a-a are supported on jewel bearings. A fixed soft iron core is usually mounted inside the coil to improve sensitivity and linearity.

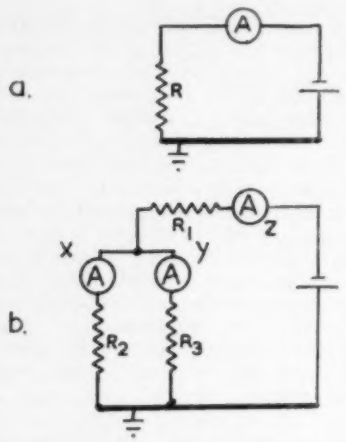


Fig. 10. (*a*) **To determine the current flowing in a circuit the ammeter A must be inserted in the circuit. In** (*b*) **the whole current flows through the ammeter at Z and through R_1 but the current will be divided between the meters at X and Y in inverse proportion to the values of R_2 and R_3.**

deflection of the pointer when only a few micro-amperes flow through the coil. They are, however, exceedingly delicate and expensive instruments and meters showing a full scale deflection for from 1-5 mA. are more robust and generally cheaper.

Current Measurement

As the current in a simple circuit is of the same magnitude at all points in the circuit it is only necessary to insert an ammeter of suitable sensitivity in the circuit to determine the total current flowing. (Fig. 10).

In a more complicated circuit different currents may flow in different subcircuits. In the circuit (Fig. 10b) a milliammeter, inserted at X in the circuit will register the current flowing through it and therefore also through resistors R_1, R_2 and the battery. If the meter were placed at Y it would show the current flowing through resistors R_1, R_3 and the battery. A meter at Z would indicate the total current flowing in the circuit through resistors R_1 which is the sum of the currents flowing in R_2 and R_3.

It must be remembered that the meter indicates the current flowing when the meter itself is in the circuit. As the meter must have some resistance the current through the meter is not the same as the current which would flow in the circuit were the meter not present! The effect may be large or small depending on the circuit and meter resistances. Milliammeters used in electronic work may have resistances up to several hundred ohms. In Fig. 10a suppose the resistor R to to have a value of 100 Ω and the battery to provide 2 V., then the current flowing would be 0·02 A., or 20 mA. ($I = \frac{E}{R}$). If a meter having a resistance of 150 Ω were inserted to measure this current, the total resistance of the circuit would then be 250 Ω and only 8 mA. would flow and be indicated on the meter, a false indication of the real position in the absence of the meter. If, however, R were 10,000 Ω, then the current flowing without the meter would be 0·2 mA. and when the meter was inserted the total resistance would be 10,150 Ω and the current not substantially less than the real value in the absence of the meter.

For current measurements the circuit must be opened and the ammeter inserted as part of it, and for reasonable accuracy the meter must have a low resistance compared with the rest of the circuit.

Voltage Measurement

If the resistance of a meter is known, then the voltage difference between its terminals can be calculated for any current flowing through it ($I = \frac{E}{R}$). Thus a milli-ammeter can be used as a voltmeter. For example, a 5 mA. meter of internal resistance of 100 Ω gives a full scale deflection when 0·5 V. are applied, with proportionally smaller deflections for smaller applied voltages. The same meter may be used for measuring much higher voltages provided a resistance is added to limit the current to 5 mA. at the maximum voltage to be measured. If in Fig. 10a resistor R was 9,900 Ω and the meter 5 mA., 100 Ω, it would give a full scale deflection only when 50 V. were applied to the circuit. A milli-ammeter may therefore be easily adapted to measure a range of voltages by providing alternative series resistors. (Fig. 11a).

Similarly, by arranging a by-pass or *shunt* resistor only a fixed proportion of the current will flow through the meter which can thus be adapted for measuring larger currents (Fig. 11b.)

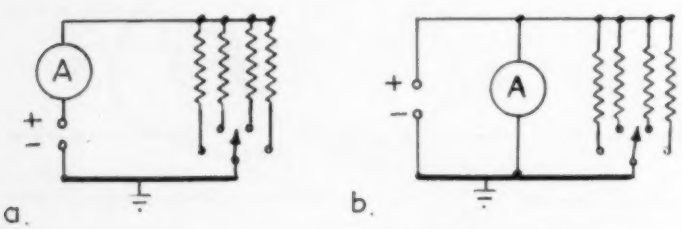


Fig. 11. (*a*) **A milliammeter and a number of high resistances which can be selected to enable measurement of various ranges of voltage.** (*b*) **The same meter with a selection of low resistances to by-pass some current to enable measurement of a range of currents.**

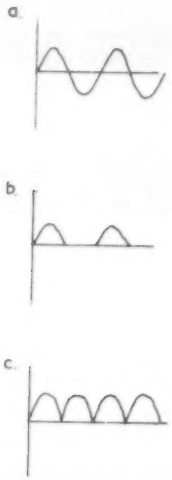


Fig. 12. (*b*) **Half wave and** (*c*) **full wave rectification of the alternating wave form seen in** *a*. **Although unidirectional, the voltage in both** *b* **and** *c* **still varies between zero and peak.**

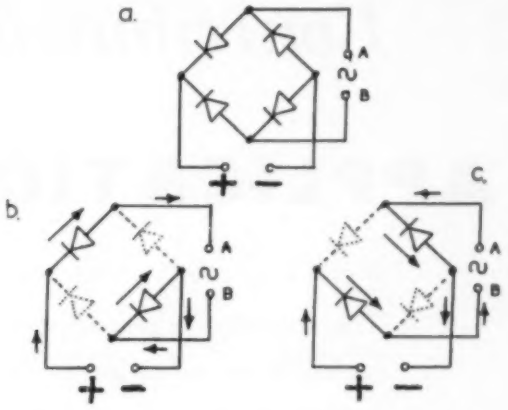


Fig. 14. (*a*) **Four half wave rectifiers arranged as a bridge to provide full wave rectification.** (*b*) **Direction of current flow during ½ cycle when A is positive and B negative.** (*c*) **Direction of current flow during ½ cycle when B is positive and A negative.**

Metal Rectifiers

Certain pairs of substances when brought into contact form a junction through which electric currents can pass only, or more easily, in one direction. Copper and copper oxide are such a pair.

If an alternating current is passed through such a junction a current can only flow during that part of the cycle in which the electron flow across the junction is in the right direction, and the current in the circuit will become undirectional though intermittent. (Fig. 12b.) This is known as half-wave rectification. In practice rectifiers, for conversion of a.c. to d.c. in this way, are composed of a series of such surface junctions in disc form, connected by a third inactive substance, and mounted on a non-conducting rod. As the rectifier produces some heat cooling fins may be attached between discs. (Fig. 13.)

By connecting four rectifiers as shown in Fig. 14a flow of electrons is possible irrespective of applied polarity, but the polarity of the output is constant. Thus the whole a.c. wave is made unidirectional (Fig. 12c.) This is known as full wave rectification.

Measurement of A.C. Voltage and Current

Because direction of current flow determines the direction of movement of the pointer in a moving coil

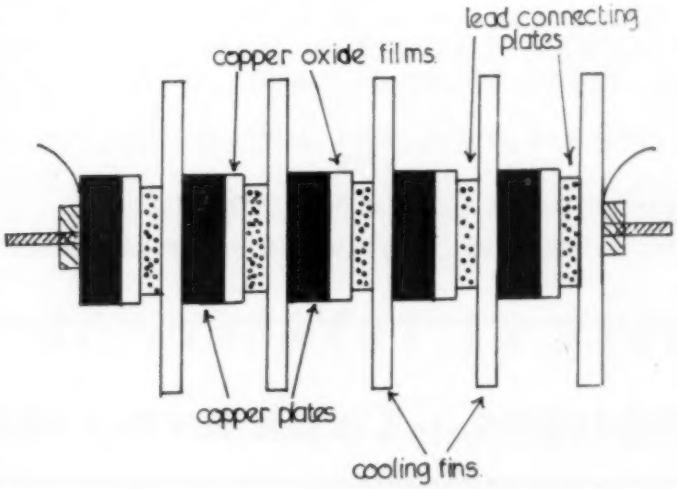


Fig. 13. Diagrammatic representation of a copper-copper oxide rectifier. The oxide layer is in fact relatively thin and limits the maximum voltage that can be applied per pair of plates.

Contributed by **ELGA PRODU**

APPLICATIONS OF ION EX

The complete Chemical Purification of water by deionization is now widely accepted as an invaluable technique for laboratories and many industrial applications. Other applications of ion exchange are, perhaps, not so well known, and some are now briefly described.

REMOVAL OF METAL ION CONTAMINANTS

Ion Exchange resins may be employed to effect complete and rapid removal from solution metal ions which, because of their taste, colour, smell, or toxicity are undesirable in many processes or products. A cation resin is used, and one example is the removal of iron from phosphoric acid pickling baths. Industries using this technique include, Food Processors, Pharmaceutical Manufacturers, Textile Mills, Chemical Manufacturers, Dye Works, Tanneries and Paper Mills.

RECOVERY OF METALLIC IONS

Valuable metals in aqueous solutions can be adsorbed on a suitable Cation resin, which is subsequently treated to recover the adsorbed metal. Typical examples of metals which may be salvaged or concentrated in this way are:—

Copper — from rayon and pickling wastes

Gold — from industrial wastes

Chromium — from plating baths

Rare Earth Metals — from their ores

Isotopes (concentrated)

Magnesium — from sea water

ELGA PRODUCTS · LANE END · BUC

CTS LIMITED

CHANGE

Part of this information has been condensed from Rohm and Haas Publication IE-3-53a.

In following issues it is hoped to deal with one or more of these applications specifically.

Elgastat Deionizers are contributing to Research throughout the world by providing ultra-pure water at a turn of the tap.

RECOVERY AND PURIFICATION OF ORGANIC BASES

Many organic bases can be recovered from reaction mixtures and waste solutions by their passage through the hydrogen form of a cation exchanger. The anion is bound to the resin as an insoluble salt, whereas the acidic and non-acidic impurities pass through the bed unaffected. Regeneration of the exchanger with acid results in the production of the pure acid salt of the base. Among bases which can be purified in this way are Alkaloids, Amino Acids, Dyestuffs, Vitamins, Amines and Acetone.

DE-ACIDIFICATION OF SOLUTIONS

The use of an Anion resin of a suitable grade enables acidic constituents to be removed from solution. Typical of the processes which have been developed is the de-acidification of formaldehyde. Commercially this contains traces of formic acid which is objectionable for some applications. This can be removed simply by passing through a bed of a weakly basic anion exchanger. Other uses include the removal of residual acids from fine chemicals, dry cleaning solvents, etc. and acid contaminants from biological preparations.

-BY APPOINTMENT TO RESEARCH--

INGHAMSHIRE *Telephone: Lane End 396*

P.6271A

VARIATIONS AND ERRORS IN EXPERIMENTAL

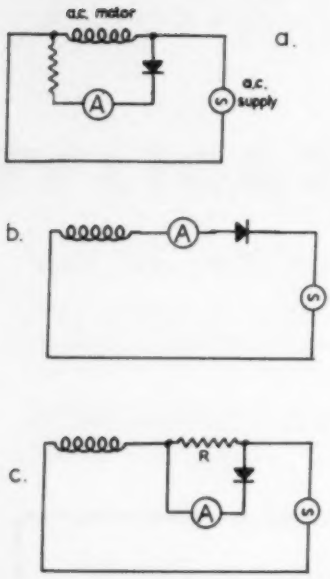


Fig. 15.

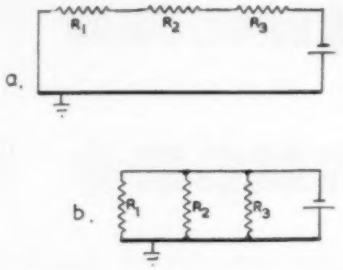


Fig. 16.

Fig. 15. (*a*) Measurement of the a.c. voltage applied to an electric motor using a milliammeter, ½ wave rectifier and series resistance. Attempts to measure the current flowing using a series rectifier (*b*) would impede proper operation of the motor. The voltage drop across a known resistor inserted in the circuit (*c*) could be determined and the current calculated.

Fig. 16. The total resistance of resistors arranged (*a*) in series is equal to the sum of the individual resistances ($R_1 + R_2 + R_3$). When arranged in parallel (*b*) the total resistance is less than any individual and equal to R where

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \text{ etc.}$$

meter alternating current merely causes vibration of the meter needle, but if the current is first passed through a metal rectifier, either half or full wave, the unidirectional output will deflect the meter normally. It is therefore possible to measure a.c. voltage with a moving coil meter by including a rectifier in the meter circuit. (Fig. 15a.) It is not possible, however, to measure a.c. current directly in this way because the current flowing through the meter, and the rest of the circuit, would have to be rectified and it is very probable that the performance of a.c. apparatus in the circuit would be affected. For example, supposing the current consumed by an a.c. motor had to be measured, insertion of a meter and rectifier as in Fig. 15b would result in d.c. passing through the motor as well as the meter. To measure the a.c. current an indirect method must be used. If a small resistor of known value is included in the a.c. circuit (Fig. 15c), then a small a.c. voltage proportional to the current ($I = \frac{E}{R}$) will be produced across the resistor. This voltage may be measured with a meter and rectifier without producing any major change in the main circuit. Alternatively the primary of a small transformer may be inserted in the circuit and the voltage induced in the secondary is then measured. Of course, the resistor, or transformer, may be built into the meter together with the rectifier and the scale directly calibrated in a.c. milliamperes to save calculation. Multi-range commercial test meters are constructed in this way so that one meter may be used for measuring a large range of currents and voltages both a.c. and d.c. Plate I shows one popular type of multi-range meter. The appropriate resistors and rectifiers are switched in and out of the circuit by means of a multi-position switch.

Plate I. A composite meter covering 18 ranges of measurement. (*By courtesy of Avo Ltd.*).

We have seen how an error in current measurement can arise by insertion of a meter of comparatively high resistance in the circuit. Similar errors arise from the use of low resistance meters for voltage measurement.

Resistances in Parallel

We have already considered circuits where two resistances have been connected together *in series* as in Fig. 16a and the resistance offered by the resistors has been

(*Continued on page 111*)

VARIATIONS AND ERRORS IN EXPERIMENTAL INVESTIGATIONS

by S. Lewin, M.Sc., Ph.D.

Physical Biochemistry Research School, South-West Essex College of Technology, Forest Road, London, E.17.

PART I—SOME GENERAL CAUSES

IT IS an essential feature of scientific investigations that the results be reproducible not only in the same laboratory, but also in other laboratories.

However it often occurs, particularly when new fields are investigated, that the results of different investigators are in conflict. One has only to consider the famous term 'biological variations' to realize what a multitude of sins it covers. Often the term 'variation' is used to cover ignorance of the various factors involved; but it may equally well be taken to demonstrate the associated uncertainties. These variations may sometimes be traced to specific factors.

The contradictions or erroneous conclusions may be due to wrong formulation of the problem itself or to some factor associated with the experimental procedure. In the latter case the result may be due to some 'simple' point, which somehow escaped scrutiny or appreciation. Such simple causes are, however, often traceable provided the various assumptions and steps forming part of the procedure are carefully examined.

Sometimes, even an otherwise reliable, experimental procedure involves a series of individually insignificant errors, the accumulation of which results in a significant error. The causes may vary considerably from one investigation to another. It is not possible to consider even a small proportion of the various causes in a short paper, and we shall therefore be concerned with some general principles which will be illustrated by reference to specific investigations.

A fundamental principle in scientific work is not to take anything for granted. Like New Year resolutions, this is sometimes forgotten or even wittingly ignored, because of otherwise over-riding considerations. It all depends on what is meant by 'taking something for granted'. If one considers the series of factors involved in a given investigation, starting from the theoretical procedure, one may indeed be impressed by the number of assumptions that have to be made in order to make the execution of the investigation at all possible.

One major cause of neglect of the above principle is failure to appreciate *all* the factors involved in the particular investigation.

Consider the first assumptions made, viz. that the *individual* techniques generally accepted and utilized in various laboratories are workable, reproducible and sufficiently accurate. This precept may well apply *individually* when the specified techniques are used under the strictly defined conditions. However, the new investigations are often associated with different conditions, although the difference may be slight, and the extension of the use of a particular experimental procedure (thoroughly tested and approved in one investigation) to another field while appearing at first sight justifiable, may nevertheless be associated with the introduction of a significant experimental error.

The above principle of not taking anything for granted is not easily enforceable. There are indeed limits to checking *everything*. Some 'reasonable' assumptions have to be made, otherwise the time spent in checking and rechecking is likely to make impossible the execution of major projects. The eventual test of whether the premises made are justified is to be found in reproducibility and applicability in other fields, as well as agreement with the results by the use of *different chemical tools*. Let us assume that the investigation has been formulated and planned efficiently. The next step is to consider the chemicals and materials to be used. It is more often than not necessary to work with materials of a high degree of purity. This can be done by preparation and/or purification of the materials in the laboratory. However, in order to save time, the tendency is to purchase chemicals of analytical purity produced by 'reputable' chemical firms, the limits of impurities being stated clearly on a label on the bottle. One should, of course, check the purity of the material by a series of tests. However, if one is to test for all possible impurities and for possible developments with time, the time consumption may be prohibitive. With inorganic analytical reagents which are used in the preparation of standard solutions for qualitative tests there is a tendency to accept the printed statement and the significance of the labelling of 'analytical reagent'. However, such acceptance may not be wise. One precaution which it is often useful to take is to check whether the firm supplying the material is the actual manufacturer or whether it is an intermediary which merely buys it in bulk, sets some backroom youngster who may not even possess G.C.E. Advanced Level in Chemistry to perform a number of tests on the 'limits of purity', and finally packs the material in a bottle with an attractive label and surcharges anything from 150 per cent to 400 per cent on top of the original price. An investigation into the background of chemical sale and resale may well shatter one's faith in the significance of the printed label.

In this connection we may relate experiences of the significance of the degree of purity of 'analytical reagents'. A quantity of glucose labelled as being of 'analytical purity' was delivered by a firm generally considered to be reputable. On opening the bottle, the

smell of pyridine was so pronounced as to be sickening. A complaint was made and the firm replaced the original batch with another batch of glucose also purporting to be of analytical purity. But alas, the second batch also smelt strongly of pyridine! The firm's representative called and explained that pyridine was not listed among the impurities permissible in any quantity and that consequently the batches of glucose were not tested for pyridine. When it was insisted that this kind of material could not be considered by any means as suitable in an analytical investigation, the firm offered to take the glucose back, eventually explaining that they were only vendors in this instance and that it would be too expensive for them to prepare the glucose afresh using a technique which excludes the presence of pyridine.

Another example concerned the delivery of NaCl of 'analytical grade'. The bottle was transparent, and one could clearly observe quite a number of red specks amongst the white NaCl crystals. A complaint was made and the bottle of NaCl replaced by another, but this time the bottle was amber coloured. Incidentally, since then practically *all* the analytical grade materials supplied by this firm and its associated companies have been supplied in amber containers. The cynic may suspect that the author has contributed to a transformation in the manufacture of chemical container bottles.

On another occasion when a Winchester quart of standard 0·100N CO_2-free NaOH was delivered, the bottle was transparent and a yellow straw, three inches long, could be clearly seen inside. A complaint was made, the bottle removed and replaced, but the representative pointed out later that, despite the presence of the straw, analytical tests showed that the solution was exactly 0·100 N, and that therefore the presence of the straw did not strictly affect the specification on the label.

Let us assume now that the degree of purity of the materials available has been checked and has been found to be satisfactory in that it is relatively high, say 99·98 per cent and that the experimental technique has been shown to be acceptable. There are still many major factors which can lead to experimental variations. The following may be mentioned in illustration:

1. Trace Elements

The presence of certain elements or substances in *trace* quantities has been shown to be responsible sometimes for experimental variation. The classical case is that of the catalytic effect of traces of water on the interaction of a number of compounds. However, this factor is not of importance in reactions which employ the medium of water.

The interaction of aminoacids with sugars, where the results of a number of investigators have been in conflict, shows the effect of trace elements quite clearly. Thus, Bohart and Carson (1955) using optical methods, have shown that the development of brown colour, often termed the 'browning reaction', is strikingly affected by the presence of trace metals. As little as 0.4 p.p.m. of manganese retard the development of the brown colour, in the post-initial stage of the interaction, by over 20 per cent, while the presence of 2 p.p.m. of Fe result in acceleration of colour development by over four to five times.

One may therefore wonder whether the conflicting results in a number of investigations may not have been due to the presence of trace quantities which are difficult to determine.

In this connection it is desirable to emphasize the importance of the choice of cleaning method utilized in the investigation.

The use of erroneous cleaning techniques results in significant errors. For example, consider the use of chromic acid for cleaning glassware. (See also, Lewin, 1955.) The vessel is usually kept in the acid for several hours and the chromic acid is strongly adsorbed and even penetrates the glass (experiments have shown that Pyrex floats cleaned with chromic acid have different densities from the untreated ones).

Even after 12 washings with distilled water it is possible to demonstrate the presence of some adsorbed chromic acid which offsets the test for a number of steroids and other compounds.

Yet a number of chemists still use this method. Worse still, many scientific papers do not give any information concerning the cleaning methods adopted.

2. Light

The catalytic effect of sunlight on chemical reactions, even though it may be diffuse, is well known and is illustrated by the hydrogen—chlorine interaction. Many of the catalyses are associated with U-V radiation. One wonders what contribution modern fluorescent lighting makes in this connection.

3. Aerobic v. Anaerobic Conditions

The presence of oxygen is now known to affect a number of reactions. The original inappreciation of the effect of this factor can be illustrated in the aminoacid—sugar interaction.

One may follow the interaction using different experimental tools, such as pH depression, oxidation-reduction capacity or optical density. In the first stage of the interaction, which as a result of investigations in this laboratory in the neutral pH range of c. 5-9 may be characterized as the first steady pH state, and at 20° C., the presence of air can be shown to be without effect. However, it is a mistake to extend this conclusion to subsequent steady pH states or to higher temperatures, or to initial pH values in the more alkaline range. Indeed, investigations in this laboratory (Lewin, 1956; Lewin and Kosinski, 1958) have shown that already at 30° C., the presence of oxygen affects the pH depression values in the second and subsequent steady pH states in the higher glucose concentrations. Also Bohart and Carson (1955) have shown that the development of brown colour in the post-initial stage is affected by the presence of oxygen.

4. Storage

The saving of time and effort frequently requires the preparation of larger quantities of 'stock' solutions, and it is often assumed that such solutions are stable.

The stability of the solutions may be demonstrated by paper chromatography and by other reliable methods, using 'standard' conditions. However, the conditions are occasionally altered somewhat and the premise is then erroneous. Sometimes the storage conditions are insufficiently defined, and the investigator attempting to repeat the original investigation or procedure uses non-identical conditions unwittingly. In some instances the storage condition variation does not result in a significant effect, but in other cases an appreciable experimental 'error' may be encountered.

Light and temperature effects often play an unappreciated but nevertheless significant role in storage. For example, it may be demonstrated that certain reagents which have been kept in a cupboard for three months have not decomposed. It is therefore stated that 'solutions of the substance when stored for three months have shown no signs of decomposition'. An investigator attempting to reproduce the results may keep the solution on the *shelf* for only one month and find that the solutions already show signs of decomposition. As the exact conditions of storage have not been specified in the original paper, the investigator may be forgiven for thinking that the results of the original investigator are not reproducible. The same type of experience and consideration may well apply to storage during summer conditions when contrasted with winter storage.

The effect of storage on pH may be quite pronounced even though only a small time interval has elapsed. Thus, aminoacid solutions may be kept at pH 8·5 anaerobically at 20°C. in subdued or diffused lighting for over six weeks without any signs of decomposition. However, if the pH is raised to 9·5 it is not safe to assume that the solutions will be stable for more than one or two days under otherwise identical conditions.

Length of exposure to the atmosphere can effect the pH values of poorly buffered solutions. In the titration of a weak acid with a strong base the end-point is often determined by means of an acid base indicator such as phenolphthalein. The absorption of atmospheric CO_2 by the solution results, however, within a few seconds of shaking in a pH drop when the end-point should have been reached. This results in the disappearance of the pink colour of the indicator until *more* than the correct quantity of the strong base had been added.

An increase in pH value, on the other hand, may be noted on storage in other cases. A striking effect can be noticed in the case of mammalian semen pH which intrinsically contains some carbonic system buffer. If the container is left open, loss of CO_2 to the atmosphere takes place and the pH of the solution rises significantly. For example, the pH of rabbit semen contained in a wide mouthed test tube open to the atmosphere can change from pH 6·8 to 7·7 in just over an hour at room temperature.

Peculiar pH effects have been occasionally recorded and were at one time erroneously ascribed to general factors. A certain laboratory technician whose duties involved checking the stability and accuracy of glass electrodes, using a very sensitive pH meter, found that he was unable to calibrate the glass electrodes on certain occasions while on other occasions no trouble was encountered. It was noted that other members of the laboratory were able to operate the glass electrodes satisfactorily on those days when the laboratory technician was unable to do so. A subsequent observation was that the laboratory technician's 'off days' were usually on Tuesdays and Thursdays. On one occasion he came in grumbling that his cotton shirts were not ready and that therefore he had to put on a nylon one. It was on that day, which was neither Tuesday or Thursday, that he had difficulty in obtaining accurate calibrations. It appeared therefore that for some reason the nylon shirt was associated with the 'off days'. He was requested to change his nylon days and it was soon noted that a shift in the off days followed automatically. Presumably the static charge on the nylon shirt in the case of this man was the source of the trouble. He stopped wearing nylon shirts on days of glass electrode standardizations and his results improved considerably. This is an example where home procedures affected pH readings in the laboratory.

We have discussed so far but few of the general causes which can lead to experimental variations. There are many others. In subsequent articles of this series other factors and facets will be considered.

(To be continued.)

REFERENCES

Bohart and Carson (1955). Nature, **175**, 470.
Lewin (1955). Lab. Practice, **4**, 441.
Lewin (1956). Biochem. J., **63**, 14.
Lewin and Kosinski (1958). Trans. Farad. Soc., **54**, 222.

Award to Sir Cyril Hinshelwood

The Council of the Royal Society has accepted an offer by the Trustees of the Leverhulme Trust Fund to mark the occasion of the Royal Society's Tercentenary, by the award of a gold medal. Under the terms of the offer the medal is 'for award by the Society, every three years, to the individual who in the opinion of its Council shall have made the most significant contribution in the field of pure or applied chemistry or engineering including chemical engineering. The medal, which will be in gold, will be accompanied by a monetary award of five hundred pounds.'

The Council has made the first award of the medal to Sir Cyril Hinshelwood, O.M., F.R.S., who retired as President of the Royal Society on November 30 last, for his outstanding contributions to physical chemistry.

The Institute of Metals

The Council of The Institute of Metals has elected Prof. W. Hume-Rothery, O.B.E., F.R.S., Isaac Wolfson Professor of Metallurgy in the University of Oxford, as an Honorary Member of the Institute.

The Council has also elected Major C. J. P. Ball, D.S.O., M.C., Dr. Maurice Cook, C.B.E., and Lieut.-Colonel S. C. Guillan, T.D., as Fellows, in recognition of the services that they have rendered to the Institute.

APPARATUS AND DEVICES

STOP-ACTION CONTROL OF DELIVERY FROM BURETTES

by M. A. Fill, F.R.I.C., and E. H. Wren, *Norwood Technical College, London, S.E.27*

DURING the last decade considerable improvements have been made in the methods of manufacture, and accuracy in calibration, of volumetric apparatus and of burettes in particular. Although plastic burette stopcocks, which have obvious advantages, are now commercially available, it is surprising that possible improvement to the glass stopcock has not attracted more attention. It is well known that control of the flow through an ordinary stopcock is effective only within a few degrees of rotation so that even an experienced operator will occasionally overshoot an end-point.

A more positive control at the drop-stage of a titration is not only desirable but often necessary. This became evident during a recent investigation in which the course of a reaction was followed by titration. In view of the high initial velocity of the reaction, a burette control was required capable of giving a split-second change-over from the full flow stage to a predetermined drop rate. To meet the requirements of this investigation several improved types of burette control have been devised; two of these are described because of their simplicity of construction.

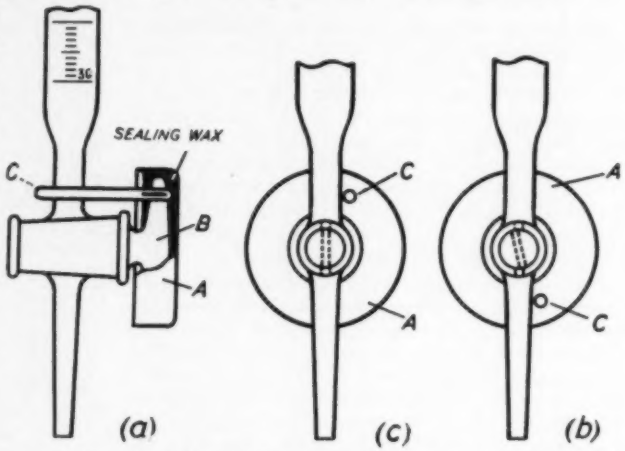


Fig. 1 (*a*) **Shows construction of the stop-action control fitted to an ordinary stopcock.** (*b*) **Backview of** (*a*) **showing pre-set position of stop C effecting drop-stage control, and** (*c*) **full-flow.**

A Simple Flow-rate Control

One method of obtaining a more positive control over the drop-stage by a simple modification to the conventional type of burette tap is shown at (*a*) in Fig. 1. It consists essentially of a Bakelite chemical cap A sealed on to the burette key B by means of sealing wax. Stop C is positioned in the sealing wax so that a suitable drop-rate is obtained when the control knob is turned until the stop contacts the delivery end of the burette, as shown in the backview of the control at (*b*) in Fig. 1. On turning the control knob in the reverse direction the stop contacts the burette tube above the stopcock barrel as shown at (*c*). In this position full-flow is obtained.

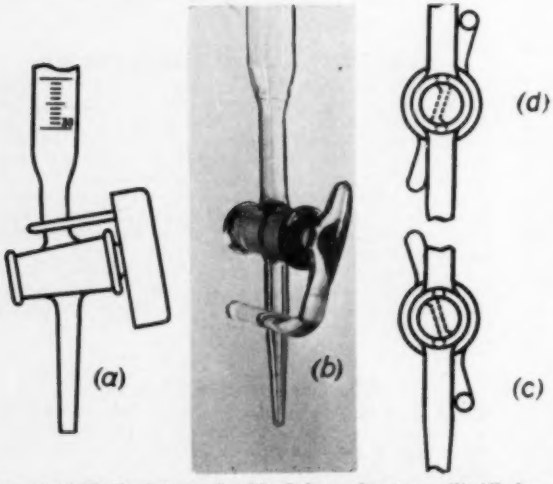


Fig. 2 (*a*) **Inclined stopcock with obvious advantages.** (*b*) **All-glass stop-action control.** (*c*) **Back view of** (*b*) **showing position of stop effecting drop-stage control and** (*d*) **showing grooves cut at the top and bottom of the drilled way to effect full-flow.**

On turning the control knob when in the full-flow position a few angular degrees backwards and forwards against the stop, a rapid intermittent flow is obtained. When the titration is approaching the end-point the control knob is turned in the opposite direction until the stop locates the delivery end of the burette to give dropwise control. Similarly, by turning the control knob backwards and forwards against the stop in its lower position intermittent drops are dispensed.

When horizontal, the weight of the modified key is such that the head of liquid in the burette may cause it to 'ride' in the barrel. It is therefore necessary to press the key lightly into the barrel when operating the stopcock. Inclining the stopcock at about 30°, as shown at (*a*) in Fig. 2 renders this precaution unnecessary.

Stages in construction are as follows:—A Bakelite cap of about 1½ in. diameter is thoroughly

roughened on the inside with the point of a needle and filled almost to the brim with stationery sealing wax, previously melted in a shallow tin. A small flame is played over the surface of the molten wax until it runs freely and adheres to the walls of the cap. The arms of the key are warmed by a pilot-size flame and placed centrally in the molten wax and held in position until the wax becomes viscous. The plug is then lightly greased and quickly inserted into the barrel and the Bakelite cap manoeuvred centrally into position while the wax is still pliable. When the wax has hardened the burette is cleaned, fitted to a stand, filled with distilled water, and the control knob adjusted to give a suitable drop-stage delivery, i.e. about one drop per 2 seconds when the burette reading is around the 25 ml. mark or near to the estimated end-point.

The control knob is secured in position by elastic bands, the burette emptied and supported in a horizontal position with the flat side of the Bakelite cap resting downwards on the bench. Stop C, is a 3 cm. length of a stout darning needle or nail of about 1-1·5 mm. diameter. The eye-end of the needle or head of the nail is heated in a Bunsen flame and this end slowly pushed down into the sealing wax so that the needle or nail stands in a vertical position in the Bakelite cap and just touches the jet tube, as shown in the backview of the control at (*b*), in Fig. 1. After the wax has set the drop rate of the burette is checked and any necessary adjustment is made by warming the stop just above the wax with a small flame until the wax softens sufficiently to enable the stop to be moved slightly backwards or forwards until the jet tube is correctly engaged. To effect full flow the control knob is now turned in the opposite direction until the stop engages the burette tube above the barrel. Provided that the drilled way of the stopcock key is not less than 1 mm. diameter the small angular displacement caused by the small diameter of stop C has negligible effect on the full flow rate. After cleaning, the burette is assembled ready for use.

This type of rapid stop action burette control is particularly suited to routine work since little manipulative skill is necessary in its operation. The Bakelite knob permits a light finger grip control and is much easier to manipulate than the conventional type of key. The ease of control at the drop stage permits a fraction of a drop to be formed at the tip of the delivery jet. This is an advantage where the titration is carried out to within less than a drop and this may be effected by transferring the bead of liquid formed at the delivery jet by contact with the inside of the neck of the titration flask followed by washing down into the flask with distilled water.

The control is also particularly suited to 1 and 2 ml. burettes as used in small scale titrimetry, where the burette tip dips below the surface of the liquid being titrated.

The control may be fitted to any single-way stop-cock through which either full flow or controlled flow of liquids or gases may be required; with modification it may also be fitted to a two-way stopcock.

The Bakelite cap fitting is particularly useful for mounting disc-shaped labels. This is an advantage in complex assemblies where several stopcocks may be used, as operational data, i.e. number of control, direction of rotation, etc., may be printed on the labels.

A simple all-glass modification of this control device may be made by sealing the glass stop directly on to one arm of the key and bending it at right angles parallel to the axis of the barrel, as shown at (*b*) in Fig. 2. After adjusting the tap to give a suitable drop stage delivery the stop is carefully heated by a small flame below the elbow of the joint and bent so that its projecting end just engages the jet tube. On account of the large angular displacement caused by the diameter of the stop it is necessary to cut grooves at the top and bottom of the drilled way to effect full flow when the stop is turned to locate the burette tube above the barrel as shown by broken lines at (*c*) and (*d*) in Fig. 2.

Although a triangular file may be used to cut a V-shaped groove it is not recommended on account of possible chipping of the ground surface. A safer method is to grind the grooves lightly by means of a darning needle of about 1 mm. diameter, coated with medium emery powder, and lubricated with water. The opposite side of the drilled way may be protected during the grinding operation by inserting a short length of

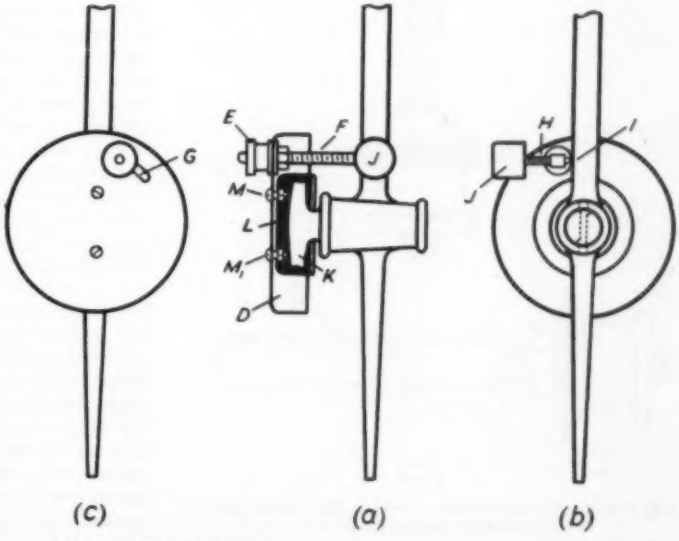


Fig. 3. Fine control burette stopcock. (*a*) side view (*b*) back view (*c*) front view. Stopcock is operated by turning the fine control knob J in a clockwise direction.

string through the way of the plug and tightly securing it on the opposite side of the plug with a knot. After cleaning, the burette is assembled ready for use.

A Stopcock with Fine Control

Fig. 3 shows a fine control burette stopcock equal in performance to the one previously described,[1] but possessing a wider degree of control over a selected rate of flow. A rapid on-off action makes it particularly suitable for microburette control and for extremely fine control of gases.

Control knob D is first adjusted to give a suitable maximum flow rate. Retaining terminal nut E which secures the fine control assembly F is loosened in slot G and the threaded rod H is positioned so that its rounded end I locates the burette tube centrally above the stopcock and at right angles to it as shown at (*a*) and (*b*). On turning the fine control knob J in a clockwise direction the end of the threaded rod moves against the glass tube causing the tap to rotate a fraction of a degree. Using a 6 B.A. thread operating at a radius of about 20 mm. from the centre of the tap, about eight

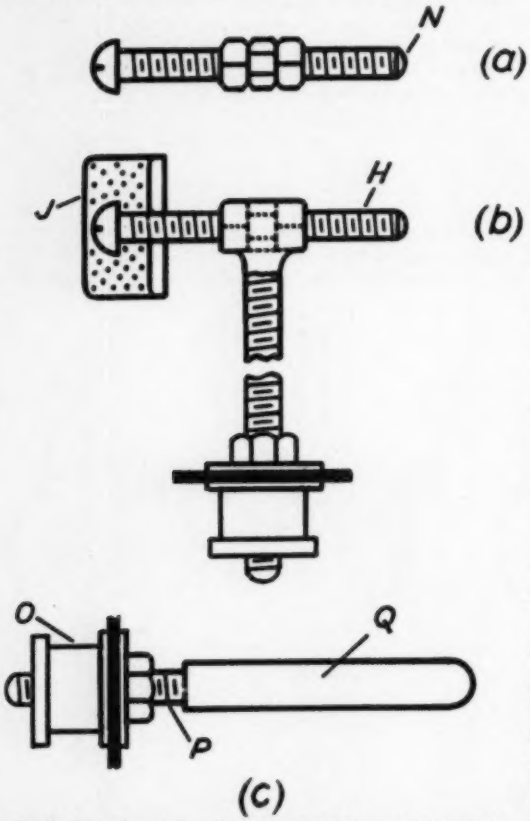


Fig. 5. Stages in construction. (*a*) and (*b*) fine control assembly and (*c*) stop assembly.

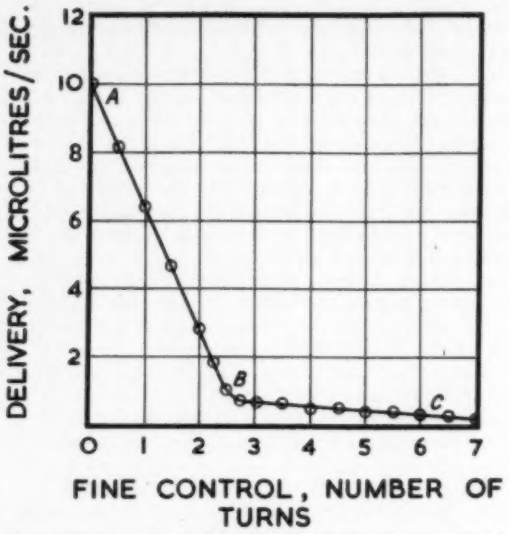


Fig. 4. Degree of control obtainable with the fine control stopcock.

turns of the fine control knob are required to span a drilled way of 2 mm. diameter. It is an advantage to incline the stopcock as shown at (*a*) in Fig. 2.

At the initial stage of titration the fine control is adjusted to give a suitable flow rate; intermittent flow is obtained by merely turning the control knob D a few angular degrees backwards and forwards using the end of the threaded rod as a stop. If an increased rate of flow is required, the fine control J is simultaneously turned anti-clockwise and lightly pressed in a forward direction so that the end of the threaded rod engages the tube above the barrel throughout the operation. This technique dispenses with the use of a rubber band to press the stop against the tube, gives a more positive action and prevents excessive pressure on the tube. If a groove or tail is cut at each end of the drilled way in the plug, shown in broken lines at (*b*) in Fig. 3, a greatly reduced flow may be obtained by adjusting the stop so that, while the original orifice is occluded, liquid may enter and leave the drilled way *via* the grooves.

The fine control may be fitted with advantage to almost any type of vertical or horizontal gravity flow tap control burette, e.g. the Bang, Eissner, and Wilson type of microburette[2].

Degree of Control Obtained

The degree of control which may be attained was demonstrated by using a micro-burette constructed by sealing a 50 ml. burette stopcock to a 1 ml. pipette graduated in 0.01 ml. Typical flow rates are plotted in Fig. 4; the efflux rates were obtained by timing the flow of distilled water between 0.00 and 0.81 ml. calibrations with the tip of the jet (which had been drawn out to a fine bore) dipping beneath the liquid surface. Curve BC shows the reduced flow rate obtained

when a tail is ground into the end of the drilled way as compared with curve AB for the same stopcock without a ground tail.

Where flow rates down to about 0.001 microlitres/second are required it is absolutely necessary after cutting the tail to regrind the plug into the barrel so that a trace of lubricant permits free rotation.

Details for constructing the fine control are as follows:—The arms of the burette key K are shortened by cutting the ends with a file and breaking them off with pliers. As previously described, the arms are set into sealing wax in a 1¼ in. diameter Bakelite cap L which is clamped to a similar cap D, of about 2 in. diameter, by means of two 6 B.A. nuts and bolts (M, M[1]) as shown in the side view, Fig. 3(*a*). The fine control assembly F is constructed by soldering a 1½ in. length of 2 B.A. rod on to three 6 B.A. nuts lightly tightened together on a greased 1½ in. 6 B.A. bolt shown enlarged at (*a*) and (*b*) in Fig. 5. A blob of solder applied at the threaded end of the bolt is smoothed with emery paper to produce a hemi-spherical end N; this prevents abrasion of the glass when the fine control is operated. A Bakelite knob of about ½ in. diameter is sealed with sealing wax on to the head of the bolt as shown at (*b*).

A tailed groove, about ⅛ to ¼ in. in length is cut at each end of the drilled way in the plug using the non-cutting edge of a medium hacksaw blade (about 1/32 in. thick) armed with fine emery powder and water as lubricant. A very fine tail may be cut, or the coarse groove extended, by using the blunted edge of a razor blade.

The stopcock shown in Fig. 1 may also be modified to give an adjustable drop rate. To do this the arms of the key B are shortened and sealed with sealing wax into L of the double Bakelite cap assembly shown at (*a*) in Fig. 3. The fine control fitting F is replaced by the stop shown at (*c*) in Fig. 5. The key B is positioned in L so that when the stop locates the jet of the burette the drop stage can be quickly adjusted, if desired, by merely sliding the stop in the slot G and securing it in position by means of terminal nut O. The stop is constructed from 2 B.A. brass rod P. A sleeve of glass tubing Q sealed on to the rod by means of sealing wax protects it against corrosion.

REFERENCES

[1] J. T. Stock and M. A. Fill (1946). Analyst, **71**, 142.
[2] R. F. Milton and W. A. Walters (1955). 'Methods of Quantitative Micro-Analysis', Edward Arnold, London. p. 156.

A CONSTANT PRESSURE HEAD APPARATUS

by C. C. Harris, B.Sc., Ph.D.

Mining Department, The University, Leeds, 2.

IN a previous issue[1], an apparatus for maintaining constant feed to a chromatography column was described. With modifications, this method is capable of accurately maintaining a fluid at a predetermined level and therefore it can provide a constant pressure head. It is particularly useful when distilled water or a fluid other than tap water is used, thus ruling out the usual 'overflow to waste' constant head device. One example of its use in this Department[2,3] is shown in the diagram (Fig. 1). The tap enables the reservoir to be refilled *in situ*.

With water, surface tension effects at the opening to the feeder produce variations in pressure head amounting to a few millimetres; this would be hardly noticeable with organic solvents whose surface tension is generally low. However, it was found that coating the feeder with a chloro-silane compound ('Repelcote') reduced this disadvantage, due to the high air/water/glass contact angle, and control was possible to about ±1 mm.

Two tubes from the reservoir, one an outlet for water only, the other an inlet for air, can lead to further improvements. A constant head tank with a large water/air area can also help to smooth out pressure fluctuations.

REFERENCES

[1] Lindley, G. (1960). Lab. Practice, **9**, 176.
[2] Harris, C. C. and Smith, H. G. (1957). Second Symposium on Coal Preparation, Leeds University, Paper 9.
[3] Harris, C. C. (1959). Ph.D. Thesis, Leeds University.

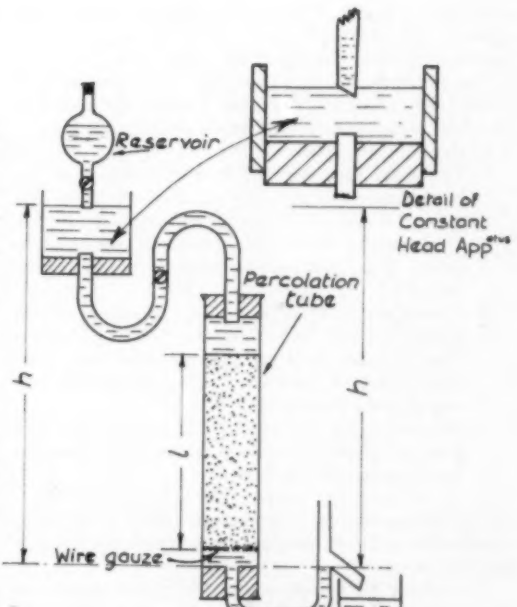


Fig. 1. Apparatus for measuring permeability.

A Simple Elutriation Separator for Mixed Bed Ion Exchange Resins

by D. H. Constable

University College of Ghana

IN a previous article (July 1959) the respective merits of single and mixed bed water de-ionizing columns were discussed, and a suggestion put forward that a combination of both principles was most advantageous. A practical application was described and a commercial apparatus working on this principle is available.

Although the supply of monobed de-ionized water to a mixed bed column ensures long life for the latter, its life is not infinite. This is particularly so if operated intermittently when there is considerable 'breakthrough' of the monobed at the start of each run, and there is the very sudden breakthrough when the monobed is exhausted, the effect of which depends on how frequently the monobed water is being monitored.

Factory regeneration of the exhausted mixed bed resin is not cheap and for laboratories overseas can be very inconvenient unless large replacement stocks are held.

The piece of apparatus to be described here is simple to make and separates the two resins most efficiently with the minimum of skilled attention. It employs the upward elutriation principle taking advantage of the appreciably lower density of the anion resin.

The apparatus is shown in Fig. 1. It consists of a 1,000-1,500 ml. cylinder without a spout, the open end of which is closed by a well fitting three-hole bung.

In the bung are fitted:

1. The inlet tube for which a cut down 50 ml. burette (without tap) is a suitable size. This tube extends to the bottom of the cylinder and its lower (wide) end is cut sufficiently slantwise to ensure that it will not fit against the bottom of the cylinder.
2. A charging funnel of 6-10 in. diameter closed inside the neck by a bung into which is fitted a rod long enough to protrude from the top of the funnel and to form an effective handle for unstopping the funnel.
3. An outlet tube of 4-6 mm. I.D. right angled and protruding into the cylinder about 2 in. below the lower surface of the bung.

Both the inlet and outlet tubes have at least 12 in. of flexible tubing of a convenient diameter for easy connection and disconnection to a water tap fitted to each of them.

To operate the apparatus the inlet is connected to a water tap and one quarter of the cylinder is filled with tap water. The funnel is filled with some of the exhausted mixed resins, the bung is gently eased out and the resins washed into the cylinder. The funnel is refilled with more resin and washed into the cylinder until the latter is three quarters full up to the outlet tube orifice. The rate of entry of the resins will have to be controlled by the funnel bung as otherwise they will tend to swirl up and be lost through the outlet.

The funnel is then closed, a 4 l. beaker placed under the outlet, and the apparatus positioned so that the beaker can stand in a sink. The inlet water is turned on *gently* when the resins will start to rise in the cylinder by flotation. When they approach within 1-2 in. of the outlet, the water flow must be adjusted to maintain them at that level for about five minutes. The water flow is then stopped and the resins allowed to settle when a clearly defined boundary line should be visible within the resin column. If this line is at all indistinct the flotation and settling should be repeated until the line is sharp.

The inlet water flow is then again restarted *gently* and increased until the resin reaches the outlet and begins to pass through it into the beaker. The water flow is continued as long as the boundary line remains sharp. As soon as the line begins to waver the inlet flow must be stopped and the resins allowed to settle. It will

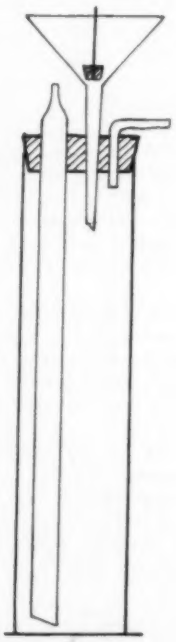


Fig. 1.

be found impossible at this first attempt to get the boundary line up to the outlet and under no circumstances should the line be allowed to enter the outlet. Some more exhausted mixed resin should then be added to the cylinder via the funnel up to the three quarters mark and the flotation repeated until a *single* sharp boundary is again obtained. The expulsion of the upper layer is repeated as before, and this time it may be possible to raise the boundary up to the outlet without any loss of definition. If not, stop, recharge, separate, and again expel the upper layer. When it is possible to get a sharp line right up to the outlet do not let it go any further but keep it there for a short while to allow all the lighter anion resin to be floated off. A 99 per cent separation can be effected in this way without difficulty. The inlet flow should now be stopped, the inlet disconnected from the tap and led into a beaker. The outlet is connected to the water tap and the cation resin backwashed out of the cylinder via the inlet tube. This will be found much easier and cleaner than trying to force it out of the outlet by excessive inlet water flow (and pressure).

The two resins having been separated in this manner the cation resin should be leached with 10 per cent HCl and the anion resin with 10 per cent NaOH. Each resin should then be washed separately with two changes of tap water and then each leached with de-ionized water to a pH of 4 or more for the cation resin and 10 or less for the anion resin. The resins can then be remixed and are ready for re-use.

The use of a cut down burette has been suggested for the inlet. Narrow tubes are found to 'choke' easily with resin when not in flowing motion. In practice this happens at almost every filling when using a small bore inlet. Too narrow an inlet tube also gives excessive water speed at the base of the cylinder leading to swirling and disturbance of the boundary at desirable flow rates. Old burette tubes are commonly available. It is advantageous to have a convenient neck diameter for the flexible tube needed for standard laboratory taps.

AN APPARATUS FOR THE DETERMINATION OF VOLATILE ACIDITY

by B. D. Powell, M.A., Ph.D.

Cadbury Bros. Ltd., Bournville, Birmingham

DURING research on the flavour of chocolate it was necessary to determine the volatile acid content of the cacao beans from which the chocolate was made. In the beans under investigation, the volatile acid was almost entirely acetic.

Steam distillation with conventional apparatus or with the more specialized apparatus for volatile acidity (e.g. A.O.A.C. method), until no more acid is evolved is unduly long, and the apparatus shown in Fig. 1 and described in outline below, was constructed. There are three main features:

1. The steam generator and distillation flask are combined.
2. The apparatus is self-contained and requires but one heater and stand.
3. Quantitative results are possible in 30 minutes, and have adequate reproducibility ($\pm$ 2 per cent).

In the experiments 1 g. of ground cacao cotyledon and 50 ml. water were introduced into A, and the contents raised to boiling point by steam entering through the side tube B, and by heat passing through the walls of A. The distillate, condensed in the vertical condenser, was collected in a 250 ml. measuring cylinder and when full to the mark, titrated with standard alkali. Multiplication of the titre by a factor gave the original volatile acidity content of the bean, usually expressed as mg. of acetic acid per gram of dry weight of the cotyledon. This factor was determined by calibrating the apparatus with solutions of acetic acid of known strength.

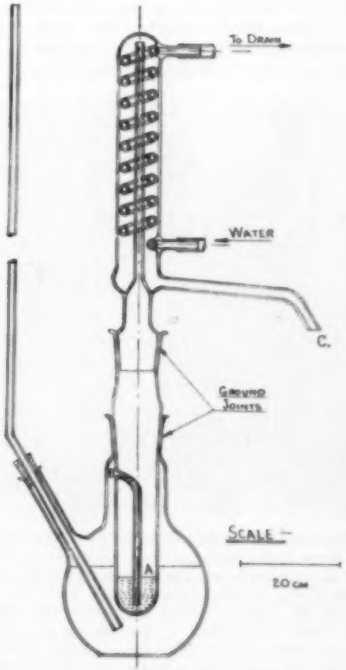


Fig. 1.

HUMIDITY EFFECTS ON MICROBALANCES

INVESTIGATION at the National Bureau of Standards has shown that the rest point of microchemical balances may be seriously altered by changes in relative humidity.[1] H. E. Almer, of the Bureau's mass and scale laboratory, found that enough moisture can collect on balance parts to move the pointer off scale. Careful design of balance components, selection of materials that absorb little moisture and maximum cleanliness will minimize this effect.

Traditional means of chemical analysis are being widely supplanted by milligram techniques, which offer the advantage of rapidity and economy. To gain even wider acceptance, however, the newer methods must offer the same degree of accuracy as those they replace. In microanalysis the errors due to weighing are often significant. The identification and reduction of these errors, such as that due to humidity, will increase the useful applications of microanalysis.

In this study, the effects of changes in humidity upon four balances of different design were determined. Two of the balances were of two-pan, equal-arm construction, and two were of the one-pan, direct-reading type. The humidity in the balance case was determined by an electric hygrometer. The balance indication was recorded for a short period to show the performance under room conditions. Moist air was then introduced into the balance case. After this the balance indication was recorded while the moisture escaped from the case and the air enclosed returned to ambient conditions. When large changes in rest point were noted, the balance was carefully cleaned, including the removal of lacquer and excess cement. The test was then repeated.

To determine whether certain balance parts were unusually sensitive to changes in humidity, they were weighed in a closed chamber, in which a pan was suspended by a wire from a balance above. The relative humidity in the chamber

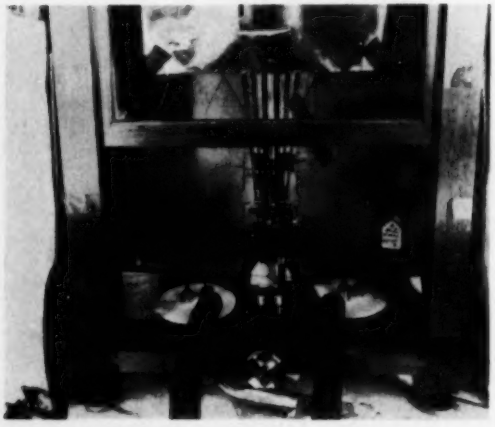


Fig. 2. Some of the equipment used by the National Bureau of Standards to evaluate the effects of changes in humidity on the rest of microbalances. To increase the humidity, air from the balance was circulated through the hoses over water and back into the balance. After turbulence had subsided, the humidity was read from an electric hygrometer (sensing elements in front left corner of the case) and the rest point of the balance was determined. Rapid and often large deviations occurred as the humidity was changed.

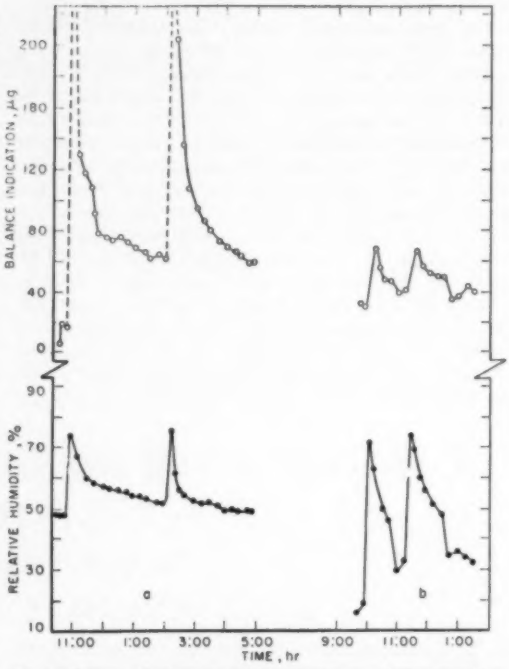


Fig. 1. Curves showing the relation between relative humidity and microbalance rest point for one of the balances tested by the National Bureau of Standards. In the condition as received (*a*) the indicator went off scale as the humidity was increased. After cleaning and removal of lacquer and cement (*b*) a much smaller effect was noted.

was altered, and any change in weight was detected by the balance. In this way the part could be checked at various levels of humidity without affecting the weighing instrument.

Each of the balances tested reacted to changes in relative humidity, reaching a new rest point quite rapidly. The magnitude of this change was different for each balance, one actually going off scale during the test. The effect on this balance was greatly reduced by removal of lacquer and excess cement. The performance of another balance that showed large deviations improved after cleaning. Changes in rest point ranged from over 8 µg. for each per cent humidity change before treatment to 0.8 µg. after treatment.

The investigation showed that moisture can collect on a balance through absorption by hygroscopic materials such as lacquer, cement, and dust, and by adsorption on all surfaces. To improve the performance of microbalances, the use of hygroscopic materials should be eliminated wherever possible, and balance parts should be kept free of foreign matter. Design considerations should include uncompensated differences in the coefficient of adsorption, and correction for inequalities in the surface area on either side of the beam.

The response of a balance to changes in relative humidity is unpredictable, and can be determined only by testing of individual instruments.

[1]Response of microchemical balances to changes in relative humidity, H. E. Almer (1960). J. Research NBS, 64C, 281.

BOOK REVIEWS

Demineralization by Electrodialysis, by the staff of the Process Development Division of the National Chemical Research Laboratory, South African Council for Scientific and Industrial Research, Pretoria. Edited by J. R. Wilson. London: Butterworths Scientific Publications. 1960. pp. 378 + xv. 60s.

This book gives a survey of the process of demineralization by electrodialysis, a technique which is now being applied on a large scale for reducing the salt content of brackish waters. It is the type of process which with further technical development could have important effects on the economies of several regions of the world.

The separate chapters are written by a number of authors who have been concerned in the South African scheme for desalting brackish waters pumped from gold mines in the Orange Free State. This scheme has resulted in the development of the largest electrodialysis plant in the world.

The book opens with a general review of the physico-chemical and engineering aspects of electrodialysis. Then follows a useful treatment of the physical chemistry of ion-selective membranes, a review of membrane preparative methods including some consideration of biological membranes and methods for characterizing membranes for use in electrodialysis. The last three chapters describe the engineering features involved in the design and operation of electrodialysis together with descriptions of the pilot and full scale plants developed in South Africa.

Altogether this is an interesting and valuable book. The first half is a useful work of reference for anyone interested in the electrochemistry of membranes while the second part gives an excellent picture of the difficulties encountered in transferring a laboratory process to a 100,000 gallon per hour plant.

The book is illustrated with a number of clear diagrams explaining the text and several photographs of parts of the large scale equipment. A comprehensive bibliography, with many references to the scientific and patent literature, is given at the end.—L. SAUNDERS.

British Pharmacopoeia, 1958, Addendum 1960. Published under the direction of the General Medical Council by the Pharmaceutical Press, London. pp. xxi + 83. 30s.

It is now the recognized custom of the General Medical Council to publish an addendum some two years following the issue of a new pharmacopoeia. This is not a matter of rectifying a large number of errors, because great care is taken to see that pharmacopoeias are free from any mistakes, including printers' errors, as far as is humanly possible, at the time of going to press. Rather is this rapid change due to the rate at which fashions, if one may use the expression, in drugs are changing. When it is necessary to include a 'Notice concerning Patents' to the effect that certain drugs have been included 'notwithstanding potential patent rights', the reader must be impressed with this desire on the part of the Pharmacopoeia Commission to be completely up-to-date. At the same time it has to be realized that many of these drugs will have an applied therapeutic life of some eight to ten years only before they are replaced by others. The Addendum contains 49 new monographs on drugs or preparations apart from alterations to very many existing monographs. The former include Corticotrophin, Liothyronine, Busulphan, Mercaptopurine, Chlorhexidine derivatives, Tolbutamide, Chlorothiazide, Halothane, Pyridostigmine, Begride, Phytomenadione, Probenicid, and Hydroxychloroquine. Changes are provided for in various tablets, and amendments have been made in the assay of certain drugs, especially antibiotics and vitamins.

It is appreciated by the assay committees that the methods of assay taken by themselves are not specific to a particular drug, nor are the identification tests specific, but speaking generally when all the various tests are carried out on a particular drug or preparation, including identification tests, melting points or other physical tests as well as the assay, there is little risk of a sophisticated article avoiding suspicion.

From the point of view of laboratory technique the greatest innovation is that of the determination of Vitamin A potency and this should be read carefully in conjunction with the monograph in the pharmacopoeia. The most interesting modification in a method of assay is that of thyroid, where it has been found necessary to extract thoroughly with 0·5 per cent w/v sulphuric acid, before hydrolizing with alkali, in order to extract lactose which may have been used for dilution. Otherwise results are apt to be too high.

When reviewing the present Pharmacopoeia the reviewer expressed gratitude that so many standard works of reference, such as the pharmacopoeia, are now being brought into line as regards size, but regretted that it had not been found possible to issue the volume in loose-leaf form for those who would wish it. It is pleasing to note that, while the Pharmacopoeia Commission have not yet seen their way to comply with this suggestion, the Swiss Pharmaceutical Society have adopted this principle for the 'Subsidia Pharmaceutica' and it is, therefore, hoped that the day is not far off when this volume will follow suit. How much simpler it would be merely to change the necessary pages in one's loose-leaf volume. The reviewer now has no less than five standard works of reference published in this form on his shelves and he keeps all his own methods of analysis in his laboratory in loose-leaf form. Even Bell's Sale of Food and Drugs has its noter-up issued on a loose-leaf principle and this is a book, which is frequently produced in court for legal purposes.—THOMAS McLACHLAN.

Fundamentals of Digital Instrumentation, by D. S. Evans, M.I.E.E. London: Hilger and Watts, Ltd. 1960. pp. 39. 7s. 6d.

This booklet deals with the problem of analogue-digital conversion. The author discusses the coding of information with particular reference to the binary scale and its variants, 'Cyclic Progressive' and 'Watts' codes. He shows how the latter systems enable ambiguities due to backlash in the gear driving systems of digitizers to be eliminated and then goes on to show how C.P. codes can be re-converted into binary ones which are more suitable for actual computation.

These preliminaries are followed by discussions of methods of sampling, storing and 'time sharing,' the latter being taken to mean the use of a single digitizer by a number of analogue inputs.

Finally there is an excellent account of the different types of digitizer and their use.

The author is to be congratulated for his compression of material which has filled at least one large American book into so small a space, his style is clear and readable and the book can be thoroughly recommended.—A. D. BOOTH.

Surface Microtopography, by S. Tolansky, D.Sc., F.R.S. London: Longmans, Green & Co. Ltd. 1960. pp. 296 + viii. 55s.

The important contributions of the author to the subject of surface topography are well known from numerous publications, in particular from his earlier book on the subject (Multiple Beam Interferometry, Clarendon Press, 1948). This new book also is confined to the method of multiple beam interferometry, and its purpose is best described in the words of the author as quoted from the preface: 'The aim of this book is to show what can be achieved by multiple-beam interferometry when it is applied to the study of the microtopographies of surfaces. This is essentially a personal record since it is exclusively devoted to an account carried out in this field in my own laboratory during the past fifteen years. . . . It must be emphasized that there has been real failure in some quarters to appreciate all the full power and elegance of a correct multiple-beam topographical technique.'

This deliberate restriction to one method and to work in his own laboratory has undoubted advantages to author and reader; it has produced a book of manageable size, written in a lively style and conveying the enthusiasm of the author and his evident enjoyment in taking these beautiful interferograms. On the other hand, the procedure is rather unusual and some readers will ask themselves what work, by the same methods or on similar objects, may have been done in other laboratories, and whether its exclusion means that it is not worth mentioning, an implication probably not intended by the author.

The book contains 23 chapters of which the first five are devoted to the description of the method and the remainder to various applications. The description of the method and instrumentation is detailed and should be most useful to the potential user. Some of the theoretical discussions of the intensity distribution in interference fringes are, however, most puzzling and would have deserved more care. How a 'series of diminishing geometrical intensity $T^2 + R^2T^2 + R^4T^2 \ldots$' (p. 11) can give Airy's formula or, in fact, any kind of description of interference effects is quite obscure, and so is the meaning of the sums of intensities (not amplitudes) on pp. 16 and 17.

Chapters 6 to 9 deal with the study of surfaces of diamonds, quartz crystals, both natural and synthetic, and phenomena such as spiral growth. Of the many beautiful photographs in this chapter the most striking was actually taken with phase contrast, a method not otherwise included in the book; it shows the well-known spiral growth on silicon carbide. A critical comparison of this method with the interference method would have been quite useful in this context. Chapter 10 deals with special techniques and with the accurate measurement of contours, Chapters 11 to 14 with cleavages, Chapter 15 with oscillations of quartz crystals and Chapters 16 to 23 with metal surfaces, indentations, distortions, abrasions, polish and wear.

For all scientists interested in surface contours this book contains a large amount of valuable information, and anyone merely turning over the pages can hardly fail to enjoy the beauty of the illustrations. In view of the number and the high quality of the reproductions, the price of the book is very moderate.—H. G. KUHN.

Approved Methods for the Physical and Chemical Examination of Water, Third edition. London: Institution of Water Engineers. 1960. pp. 74. 10s.

Standard methods for the analysis of all materials of public interest, such as water, are extremely valuable to all scientific workers. Even if they are not always the latest and best methods (and this aspect is always a matter of opinion) they afford a method of obtaining better comparison between laboratories.

The methods given in this slim volume are the recommendations of a joint committee of the Institution of Water Engineers, the Royal Institute of Chemistry, the Society for Analytical Chemistry, and the Society for Water Treatment and Examination. The original descriptions were published in the Journal of the Institution of Water Engineers in 1949 and revised in 1953. This third edition is basically the same but has been brought up to date by the inclusion of modern methods for cations, anions and synthetic aniomic detergents.

The descriptions of techniques are as complete as one could wish. Details of calibration are given and the authors have not hesitated to give their opinions on the usefulness and accuracy of different methods. A few references to original papers are given and these could usefully be increased in number. An index (not always quite accurate) completes a very useful compilation. The publishers have made their contribution by binding the work in water-repellent covers.—J. G. DAVIS.

Science Data, by J. Newton Friend. Fourth Edition. London: Charles Griffin & Co., Ltd. 1960. pp. 120. 12s.

This strongly bound little volume is intended as a handy reference book for students of chemistry and physics. It is not intended to be a text-book.

The book covers the wide field very competently. Our chief criticism is that many of the definitions could be excluded and the tables of data amplified to give increased usefulness. Thus solubilities are given only to 50°C. and temperature conversions only to about 60°C. Some highly specialized items of information could be omitted and data for buffer solutions and similar often used materials put in their place.

The size is such that the volume can easily be carried in the pocket; it can certainly become a permanent item in the scientist's brief case.

The print is rather on the small size but as the book is intended for students this may not be an important point.—J. G. DAVIS.

Quantitative Inorganic Analysis, by R. Belcher, D.Sc., Ph.D., F.R.I.C., F.Inst.F. and A. J. Nutten, B.Sc., Ph.D., F.R.I.C., M.R.S.H. Second Edition. London: Butterworths Scientific Publications. 1960. pp. 390 + x. 35s.

The fact that a second edition of this well-known work has been produced within five years of its original publication, is a tribute both to the sound treatment of the subject and to the general growth of the teaching of analytical chemistry. The book is intended primarily as a practical teaching course in quantitative inorganic analysis suitable for Universities and Technical Colleges although much of its contents will be of general value to practising analysts. Books intended for the teaching of analytical chemistry are relatively common in the U.S.A. and it is pleasant to see such an eminently practical volume appearing from a British source.

This edition continues the general presentation of the earlier volume. A limited but well-chosen list of analyses are treated and the aims are to give the student a grasp of the physical and chemical principles involved in addition to the general background of the method. It has also been the object of the authors to make the student realize that the details of the method given were not finalized long ago but have been developed by a considerable amount of work which has been published from time to time in world scientific journals. To this end the text is well provided with original literature references.

The present volume contains sections on laboratory apparatus and technique; gravimetric analysis; titrimetric analysis; colorimetric analysis; and a section of selected industrial analyses. The increasing use of E.D.T.A. as a titrant has been recognized and some of the more recent and well-tried indicators are included. The use of ceric sulphate in place of potassium dichromate has been recommended although in view of the importance of the dichromate/ferrous reaction it has still been retained. The section on balances has been extended to include the modern aperiodic single-pan balances now widely used in industry.

In the past it has sometimes been the contention of some practising analysts that University teaching of analytical chemistry has left much to be desired. Prof. Belcher and his team at Birmingham University have done much to influence the teaching of analytical chemistry and this volume reflects the advances which have been made. It is also a book which will prove of considerable value to those laboratories employing numbers of analysts who are being trained during the course of their work.—R. E. STUCKEY.

Electronics for Biologists

(continued from page 98)

simply the sum of the individual resistances, i.e. $R_1 + R_2 + R_3\ \Omega$.

It is now necessary to consider resistances in *parallel*, that is connected as in Fig. 16b. In this case the total resistance is less than that of any individual resistor and given by R in the equation:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

for example if in Fig. 16b:

$R_1 = 500\ \Omega$
$R_2 = 400\ \Omega$
$R_3 = 2{,}000\ \Omega$

the effective resistance would be

$$\frac{1}{R} = \frac{1}{500} + \frac{1}{400} + \frac{1}{2{,}000}$$

$$= \frac{4 + 5 + 1}{2{,}000}$$

$$= \frac{10}{2{,}000}$$

$$= \frac{1}{200}$$

$$\therefore R = 200\ \Omega$$

(To be continued.)

LABORATORY APPARATUS AND MATERIALS EXHIBITION

The second national Laboratory Apparatus and Materials Exhibition sponsored by* Laboratory Practice *will be held in the Royal Horticultural Society's New Hall, Westminster, from June 19-22, 1961. The June issue of this journal will be a special Exhibition Number, containing a preview of the exhibits to be shown.

Laboratory Note-Book

MR. C. G. ANDREWS chief glassblower at the National Chemical Laboratory has been awarded the B.E.M.

Mr. Andrews joined the Chemical Research Laboratory, as it was then called, in September 1927 as the first laboratory assistant. During his first years at the Laboratory he assisted in research on low temperature tars but later developed a marked aptitude for glassblowing. He improved his skill and his knowledge of glass technology by attending evening classes and his perseverance and determination were recognized when he was made responsible for all the Laboratory's glassware —including the construction of new apparatus of special design.

Mr. Andrews has been the Laboratory's chief glassblower for 13 years. This is a skilled craft calling for ingenuity and precision. It is one on which the research worker—particularly the chemist—is greatly dependent, and Mr. Andrews' work has made a major contribution to many of the Laboratory's researches. Such is his skill that he has been asked to make special apparatus for many other D.S.I.R. laboratories.

During his long service with the National Chemical Laboratory Mr. Andrews has been in charge of training young glassblowers for the National Physical Laboratory as well as N.C.L., and many of his pupils now occupy key positions in Government Service and industry.

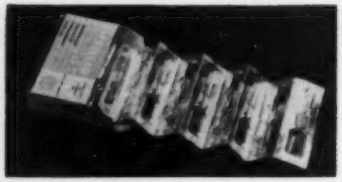
Strip-pack for Hypodermic Needles

A new aluminium foil strip package for hypodermic syringe needles is paying a double dividend for surgical instrument makers, S. & R. J. Everett & Co. Ltd. Formed on a novel automatic machine developed by Everetts and providing a sealed, sterilizable container for each individual needle, it has set a new standard of convenience and hygiene in the packaging of needles of the ordinary, re-usable type. At the same time, it is playing a big part in the development of a cheap, disposable needle that is one of the first to be marketed in this country.

The package was designed by Everetts in conjunction with Venesta Foils Ltd. It resembles the strip packages commonly used for tablets, capsules and similar items, and is formed by sealing the needles between two thicknesses of flexible packaging material. Strips of 12 packaged needles are folded concertina-fashion and placed in a simple cardboard carton.

Strip packaging has mechanized and speeded up a packaging operation which previously was largely manual. On automatic machinery adapted to Everetts' own design, the process is continuous.

The web materials used are a laminate of 0.0035 mm. aluminium foil and



0·0015 in. polyethylene film, supplied by Venesta Foils Ltd., and a polyethylene-coated cellulose film. The machines form shaped depressions in the foil web to receive the needles and, after these have been inserted, complete the packs with the cellulose film cover and a polyethylene-to-polyethylene heat seal. The finished strip is scored for easy tearing between each needle pocket and cut after every twelfth.

The original aim in examining the strip packaging system was a double one—to find a package in which the needles could be sterilized, ready for immediate use, as part of the manufacturing process, and to extend the use of automatic machinery in their packaging operations.

In the conventional needle pack, a tray of 12 or more needles overwrapped and protected by a carton, rigid box or tin, the advantage of 'pre-sterilizing' are reduced by the fact that the whole package is unsealed and potentially unsterile as soon as the first needle has been removed. The strip pack, in contrast, protects each needle individually; with care, in fact, it is possible to tear open a pack and fit the needle hub to a syringe in such a way that the 'blade' stays covered right up to the moment of use.

Development of the pack for conventional needles began last year, and limited quantities have been on the market for some months. Extensive tests have also been carried out, however, on a new type of needle designed to be supplied in a sterile condition and used only once before being thrown away. Its purpose is to relieve doctors and hospital staffs of the onus of ensuring that the needles they use are infection-free, reducing the heavy cost of sterilization in hospitals.

The new needle has a plastics hub in place of the usual, more expensive brass fitting and is not intended to withstand the high temperatures of autoclaving and other hospital sterilizing techniques. Both conventional and disposable needles in the foil strip packs are therefore sterilized, after packaging, by a room-temperature procedure involving ethylene oxide gas.

The success of the disposable needle depends on the reliability of the sterilizing process and the ability of the package to preserve sterility once this has been achieved. It is believed that the foil pack will keep needles sterile and ready for use almost indefinitely.

New World Standard of Length

A resolution introduced by the Canadian delegation recommending a new international standard for measuring length was adopted in Paris by the Eleventh General Conference of the International Bureau of Weights and Measures. Delegates from 30 countries unanimously agreed that the international standard for the metre should no longer be a metal bar kept in France, but should be defined as a specific number of wavelengths of orange light emitted by the gas krypton.

Dr. Howlett of the Canadian National Research Council introduced the resolution on behalf of the International Committee on Weights and Measures in his capacity as Chairman of the Advisory Committee for the Definition of the Metre.

Canadian scientists, notably Dr. K. M. Baird of the National Research Council, have made important contributions towards compiling evidence for adoption of the new standard. The world's only working apparatus using the new standard for directly measuring linear scales was designed and built at NRC by Dr. Baird. Four different copies of the old standard metre bar have already been measured by this instrument. The results reassured the delegates to the General Conference of the value of the new standard.

One of the advantages of the new standard is that it can be readily and accurately reproduced anywhere in the world by any well-equipped physics laboratory. Unlike the metal bar it cannot be destroyed, lost, or affected by changes in temperature or pressure.

This still from the film 'The Man in the Moon', being made by Excalibur Films at Pinewood Studios, shows extensive instrumentation used in connection with a rocket flight to the moon. Equipment by Honeywell Controls is widely used, as it is on real life rocket flights. Asked to outline the duties performed by the equipment, a Honeywell spokesman declared: 'I really don't know, really I don't; ask the gentleman in the middle, or even the one on the left—*they* might know.'

News from the British Association of Chemists

SCIENTISTS AND TAXATION

The following letter from the Hon. Editor of the B.A.C. Journal was published in 'The Guardian' of January 9, 1961:

Sir,

The Institute of Taxation has done well to focus attention on certain tax anomalies, as, for example, the notorious Schedule A. It has, however, not considered the much greater anomaly between Schedule E, under which PAYE is operated, and Schedule D, for the business or self-employed.

The Incorporated Association of Assistant Masters in Secondary Schools, as mentioned in your columns, cannot persuade the Chancellor to allow a meagre £10 to schoolmasters for books. If by some strange change of policy, it was possible for a schoolmaster to turn himself into a limited liability company' and hire the services of 'Education Ltd., to the local authority, he would be enabled to claim as much as he wished for books, for a car; he could claim a rebate on the use of his home as an office, and his wife as a secretary, under Schedule D. If it is possible for a business man or a lawyer to claim the use of his home as an office for taxation purposes, why cannot a scientist do so?

May I suggest that there should be one code only for allowances for taxation, and that should depend on the requirements of the business or profession of the taxpayer, and not in the case of professional employees on the nature of the post being held?

This might on the surface cost the Chancellor a certain amount of revenue, but it would be easy to make this up by tightening the loopholes in the present Schedule D. There is no need to have the mutual collusive wining and dining on the expense account; neither need all motoring, including that of the business man's wife, be assessed as a business expense; and the bill for decorating the home need not be passed as one for decorating the office or warehouse.

Yours &c.,
H. WARSON,
Hon. Editor,
'The British Chemist'.

SECTION PROGRAMMES

Liverpool

The Section has arranged a Lecture on 'The Social and Economic Aspects of Nuclear Energy' to be given by Dr. I. A. Campbell, Senior Lecturer in Radiochemistry, Department of Chemistry, Manchester University, on Tuesday, February 21 at 7.30 p.m. in Radiant House, Bold Street, Liverpool.

Admission to the lecture is free by ticket only, obtainable from Mr. J. H. Harwood, c/o Peter Spence & Sons Ltd., Widnes, Lancs.

Advantages of Membership of the B.A.C.

Minimum Salary Scales.
Free Legal Advice on Professional Mattres.
Appointments Service.
Unemployment Benefit.
Negotiations with employers.
Group Scheme for Private Medical Treatment.
Certain advantages in connection with Insurance.
Trading Scheme.
Benevolent Fund.
Lectures, Discussions and Social Functions.

London

The Section Annual Meeting will be held on Wednesday, February 15, 1961 at 6.30 p.m. at the Wellcome Institute, 183 Euston Road, London, N.W.1.

After the business of the meeting has been concluded, there will be a lecture by Mr. F. Jowett, M.Sc. on 'Chemistry in the Footwear Industry'.

Life Members

The following have been elected Life Members of the Association:

R. S. Allen	Elected Member 1935
J. Anderson	Elected Member 1930
A. J. Baker	Elected Member 1921
D. P. Bayley	Elected Member 1942
R. A. Burnett	Elected Member 1936
H. M. Eade	Elected Member 1931
H. Ewing	Elected Member 1941
C. D. Forbes	Elected Member 1939
A. Gardiner	Elected Member 1930
W. B. Miller	Elected Member 1931
A. M. Munro	Elected Member 1926
K. M. Richards	Elected Member 1926
M. Rosebery	Elected Member 1918
E. Wright	Elected Member 1918

NEWS FROM THE SECTIONS

East London and Essex Branch

The East London and Essex Branch of the Section held a very successful and well attended Social Evening at The Spotted Dog Hotel at Barking on the evening of January 9. This was a very pleasant, informal, purely social evening much enjoyed by members and their ladies.

In the previous week the Branch gave a Film Show in the Barking Public Library, which also proved to be very successful.

•

Birmingham and West Midlands

At the first meeting of the 1960-61 season an appreciative audience was addressed by Mrs. S. M. Tritton, F.R.I.C., M.P.S. (of the Bristol and South West Section and the Grey Owl Research Laboratories, Almondsbury, Bristol), her lecture being devoted to the subject of 'Wine-Making'.

Mrs. Tritton is an active B.A.C. Councillor and an authority on wine making, having published literature on the subject.

The audience was composed of both enthusiastic home wine-makers and those who professed to know nothing of the hobby at all.

Mrs. Tritton, however, soon added to the knowledge of the former and greatly enlightened the latter when she discoursed on the making of country wines from grapes or grape concentrate, showing how old-fashioned methods were being abandoned and proper wine-making procedures being adopted.

Different wine types were described, and the correct uses of sugar, yeasts, pectozymes, energizers and stabilizers explained. The finer points of bottling and corking were also demonstrated by the lecturer.

Having travelled to many wine producing countries, Mrs. Tritton was well qualified to describe the production of commercial wines. In this context, it was interesting to learn that of the continental wines, Germany made the best.

It could be said with certainty that the expert wine maker was better informed at the close of the lecture, while those who had never indulged in wine-making were tempted to give it a trial.

All correspondence and enquiries concerning this Association should be addressed to G. R. Langdale, Esq., The British Association of Chemists, Nominationation Dept., 14 Harley Street, London, W.1. Tel.: Museum 7021.

LABORATORY EQUIPMENT & APPLIANCES

Electrophoresis Apparatus

The increasing adoption of continuous, cellulose acetate and starch gel electrophoretic techniques is catered for by a series of 'EEL' adaptors and units which are now available for use with standard 'EEL' equipment. These ancillary devices consist of a continuous electrophoresis cabinet, a tray and slicer for starch gel samples, a tray for cellulose acetate strips, and a constant current power unit.

The continuous electrophoresis cabinet houses the electrophoretic curtain, reservoirs for the sample and buffer solutions, test tubes and capillary tubing, electrodes, etc.

The starch gel tray provides for the setting of a sample approx. 15 × 5 cm. and 6 mm. thick, which can be sliced into four layers, each 1·5 mm. by using the 'EEL' starch gel cutter which is an available extra.

The cellulose acetate tray will carry two strips each 2·5 cm. wide, and an ingenious tensioning device ensures each strip being kept taut. An available extra is the scanner adaptor which enables the electrophoretic strips to be read and plotted with the standard 'EEL' scanner.

The power unit is a constant current instrument, with a maximum output of 50 mA 600 volts, and is for use with continuous and starch gel electrophoresis.

The introduction of these devices facilitates the clearer separations obtainable with these new methods at a fraction of the normal cost, by enabling the user to employ existing equipment.
(Manufacturers: Evans Electroselenium Ltd., St. Andrews Works, Colchester Road, Halstead, Essex).

100 Kc/s Counter

Features of the 100 Kc/s counter type M1154, a transistorized digital frequency and time interval meter, include a very high input impedance, latched display and simplicity of operation. The latching system retains the display of the previous count during the time a new count is being made. At the completion of this new count the totalizer is inspected, and the display is changed only if the new total differs from that already displayed.

A wide viewing angle is achieved with in-line indicators of the projection type, the black ground screen of which ensures good readability in high ambient light levels. Separate indicators show when a count has been completed and when the capacity of the totalizer has been exceeded. Simplicity of operation

Southern Instruments 100 kc/s. counter.

is achieved by the use of a single switch to select function and range.

Unknown frequencies between 0·1 c/s and 120 kc/s may be measured using count periods of 0·1, 1, or 10 seconds. The counting interval may also be controlled manually. Time intervals defined by electrical signals or contact closures can be measured in crystal controlled clock units of 0·1 mS to 10 sec., in decade steps, to a maximum of 10,000 units. The clock units are also available at outlet sockets on the front panel.

The instrument is mains operated, and is compact, portable and robust, making it equally suitable for laboratory and industrial applications.
(Manufacturers: Southern Instruments Ltd., Frimley Road, Camberley, Surrey).

The Fluroprint

The Fluroprint is a new fully automatic x-ray fluorescence spectrometer which has been developed to analyse materials rapidly in a flexible routine. Particular aims in designing the instrument were ease in changing from one analytical programme to another, high accuracy and sensitivity, and simplicity and reliability in operation.

The Fluroprint will deal with any element having an atomic number of 12 (magnesium) or higher, and will analyse up to 20 elements in one operation. The instrument scans through the spectrum, and is programmed to stop at the appropriate angle for each element. The spectrometer is completely evacuated.

The Fluroprint works on a ratio system and pulses are counted during the accumulation of a pre-set number of counts on the monitor. Scintillation and flow proportional counters are arranged to cover the whole range of an analysis, and no adjustment is needed. To change from one type of analysis to another it is only necessary to pull out the plugboard and substitute another covering the required programme.

An electric typewriter automatically prints the results obtained from the line intensities, and interpretation is rapid and straightforward.
(Manufacturers: Hilger & Watts Ltd., 98 St. Pancras Way, Camden Road, London, N.W.1).

The Tinsley Polarograph

The Tinsley Polarograph Mark 200 is an advanced instrument designed for both research and industrial requirements. Its field of application covers investigations into electro-chemistry, stability constants of reducible compounds and characterization of certain complex organic materials. It is an accurate and sensitive analytical tool capable of trace determination of materials in solution to better than 0·02 p.p.m.

The classical d.c. circuit employed permits its operation from any type of electrode system, i.e. D.M.E., vibrating and rotating solid electrodes, or pool electrodes, etc. The electrode may be positive or negative with respect to the reference electrode.

The Polarograph Mark 200 embodies a newly designed galvanometer transistor d.c. amplifier which uses two parallel feed back circuits to adjust sensitivity in one feed back loop and speed of response in the other.

The recorder on which the final polarograms appear presents the trace on a horizontal table on which the operator may write the relevant experimental data most conveniently. The indicators for voltage and sensitivity are arranged at eye level and can be scanned at a glance while the controls which are kept at the same setting throughout a series of experiments are arranged below the recorder table.

The potentiometric recorder itself has an effective chart width of 200 mm. allied to a response time of one second and embodies its own integral amplifier.

A particularly interesting new feature is the provision of a peak reading unit (patent applied for) which eliminates capacity current noise from the normal D.M.E. and thus permits the chemist to obtain virtually undamped polarograms at all sensitivities without loss of resolution on both direct and derivative polarograms. Conventional damped polarograms may also be recorded (derivative type damping is used), and little or no zero shift will occur either with direct or derivative polarography. The potentiometer covers a voltage span from +0·5 - 3 and reverse with five scanning speeds for increased resolution.

The potentiometric recorder may also be used as a recording microammeter over its working range.
(Manufacturers: Evershed & Vignoles Ltd., Acton Lane, London, W.4).

NEWS

General

I.C.I. Polypropylene Plant in Production

Britain's first plant for the bulk manufacture of polypropylene at I.C.I.'s Wilton Works in Yorkshire is now in production. The new manufacturing unit, which has a capacity of 11,000 tons a year, will produce I.C.I.'s brand of polypropylene called Propathene.

Propathene offers to the plastics industry a plastic with a unique combination of desirable properties. It is, for instance, the lightest in weight of all commercially available plastics, having a density of only 0.90 g./cc. Propathene melts at about 165°C., which qualifies it for a number of applications where temperatures well above the boiling point of water are used. It also possesses a high degree of rigidity, greater than that of the stiffest commercially available polythenes at room temperature, together with retention of useful strength up to 140-150°C.—a far higher temperature than could safely be used with any of the general purpose plastic materials. Propathene also retains adequate strengths for many purposes at sub-zero temperatures.

Polypropylene, being a hydrocarbon, has a very low moisture absorption. The new polymer possesses a high resistance to attack by inorganic and organic liquids and offers complete freedom from the environmental stress cracking failures sometimes observed with polythene. Of particular interest is the fact that polypropylene offers a very high resistance to oils, fats and greases and may find important applications in fields where oleaginous materials are used. The electrical properties of Propathene are comparable with those of other hydrocarbon plastics.

Propathene is exceptionally easy to mould and extrude and gives articles of good strength and excellent finish. All the normal plastics plant fabrication methods—vacuum forming, machining, drilling, tapping, etc.—can be used.

Laboratory ware supplied by X-Lon Products and made from Propathene.

Publications

Plastics in the Tropics

A further report in this series, published for the Ministry of Aviation by H.M.S.O. (5s.), deals with polystyrene mouldings.

Twelve batches of moulded polystyrene were exposed for two years at five sites in Nigeria. Changes in appearance were most marked on the specimens exposed to strong sunlight; these generally darkened. No insect attack was observed on either the exposed or the buried specimens. Metal inserts had no visible effect on the polystyrene. The greatest fall in impact strength and the greatest deterioration in electrical properties were found in specimens exposed to sunlight. Impact resistant materials showed greater deterioration in electrical properties than the others at all sites. Dimensional changes indicated a slight overall shrinkage. The changes observed in softening points followed no obvious pattern.

Forthcoming Conferences

The Department of Scientific and Industrial Research has issued List No. 28 of Forthcoming International Scientific and Technical Conferences. This supersedes all previous issues.

Personal

Mr. Barry Rogel

Mr. Barry Rogel, B.Sc.(Eng.), A.M.I.E.E., has left Wayne Kerr Laboratories Ltd., to take up an appointment as managing director of the newly formed subsidiary of the Rosemount Engineering Company of Minneapolis, U.S.A. He will continue to act as consultant to Wayne Kerr and in this capacity joins Prof. A. L. Cullen, Ph.D., M.I.E.E., O.B.E., Professor of Electrical Engineering at the University of Sheffield and V. S. Griffiths, Ph.D., F.R.I.C., Reader of Spectroscopy at the Battersea College of Technology.

Mr. Rogel led the Wayne Kerr microwave design team, and in recent years has made a special study of the measurement of semiconductor parameters to extend the use of Wayne Kerr transformer bridges.

Mr. H. M. Davis.

Mr. H. M. Davis

Mr. H. M. Davis, B.Sc., A.R.I.C., A.Inst.P., recently joined Southern Analytical Ltd. as Chief Engineer and Director.

In 1937 he was with the Department of W.D. Chemist (later M.O.S. Chemical Inspectorate) and was seconded to U.K.A.E.A. Research Group in 1955. He was head of Physical Methods Section at Woolwich Arsenal and was engaged on investigation of instrumental methods of analysis. He received one R.I.C. premium in 1953 for work on cathode-ray polarography, and in 1958 was a U.K. delegate for the Atoms for Peace Conference in Geneva.

Mr. Davis will be responsible for the design and development of all the chemical analysis instrumentation at present manufactured, and contemplated for the future.

Mr. John C. Pipkin

Mr. John C. Pipkin was appointed to the Board of Directors of the Thermal Syndicate Limited, Wallsend, Northumberland, from January 1, 1961. In addition to his new duties as a Director he will continue in his capacity as Company Secretary.

Mr. Pipkin began his service with the company in 1922 as a junior member of the accountancy staff. In 1939 he was appointed Chief Accountant, and continued in this capacity until 1958 when he was promoted to Company Secretary.

The Thermal Syndicate Ltd. pioneered and established the fused quartz and silica industry at the beginning of this century, and during his career Mr. Pipkin has seen this company grow from 100 employees to nearly 1,000 today.

Dr. Masek returns from Zurich

Short & Mason Ltd., of Walthamstow, sole selling agents in the U.K. for Contraves products, i.e. viscometers, multi-test tensile strength testing machines announce that Dr. P. R. Masek, Technical Sales Rrepresentative, has now returned from a visit to Zurich, and is available for consultation and service in respect of these instruments.

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

Casella's 150th Anniversary.—To celebrate their 150th anniversary, C. F. Casella & Co. Ltd., of Regent House, Fitzroy Square, London, W.1., have issued a brochure giving details of the history of the company. Also incorporated is a section illustrating selected instruments which provides an indication of their present range of instrumentation.

B.D.H. Leaflets.—New entries in the catalogue of British Drug Houses Ltd., Poole, Dorset, are listed in the November 1960 issue of their monthly leaflet. These are: *Organic and Inorganic Chemicals*—Rare earth oxides; sorbic acid. *Microscopical Stains*—J. S. B. Stains (Nos. 1 and 2).

New entries in the December 1960 issue are as follows: *Organic and Inorganic Chemicals*—*N*-benzoyl-*N*-phenyl hydroxylamine; hydrolysed starch (Smithies) for starch-gel electrophoresis; thallium (metal) lump 99·999 per cent. *Biochemicals*—Dextran; reserpine.

Ultrasonoscopes and Accessories.—The Ultrasonoscope Co. (London) Ltd., of Sudbourne Road, Brixton Hill, London, S.W.2. have issued a new general catalogue of ultrasonoscopes and accessories for the ultrasonic testing of metals.

Laboratory Drying Oven.—A leaflet issued by Charles Hearson & Co., Ltd., 68 Willow Walk, Bermondsey, London, S.E.1. describes their new laboratory drying oven which satisfies the requirements of B.S.2648 'Performance Requirements for Electrically-heated Laboratory Drying Ovens' in respect of manual adjustment of temperature setting, variation, fluctuation, drift, reproducibility and recovery, and temperature overshoot.

Instruments for Physical Chemistry.—A leaflet describing the instruments made by LKB-Produkter Fabriksaktiebolag, P.O. Box 12220, Stockholm, 12, is available from A. Gallenkamp & Co., Ltd., Technico House, Sun Street, London, E.C.2. who are the sole U.K. agents for this company.

Laboratory Equipment and Precision Tools.—A new catalogue compiled by Henri Picard and Frère Ltd., 34/35 Furnival Street, London, E.C.4 lists the British made goods which they distribute to industrial laboratories and precision equipment manufacturers at home and overseas. The majority of the 2,000 items mentioned are primarily of interest to watchmakers and jewellers, but the following are some of the products which Henri Picard supply to industry:

Blowpipes, acid bottles, specimen boxes, Bunsen burners, celluloid squares, essence jars, electric motors, laboratory scales, tweezers, vices, ultrasonic cleaning machines, work benches, covers and trays, crucibles and furnaces, micrometer gauges, lenses and magnifiers, laboratory glasses, precision screwdrivers, and precision soldering and brazing equipment.

The catalogue is fully illustrated, with all the necessary information given in the form of captions. It is in handy loose-leaf format, with a comprehensive index in English, French and Spanish. Complementary catalogues, amounting to over 200 illustrated pages, cover tools imported from Switzerland, France and Germany.

MEETINGS FOR THE MONTH

Mid-February to Mid-March

We give below a selection of meetings of interest to laboratory workers. Details are as full as possible at the time of going to press, but readers requiring further information or confirmation of arrangements should contact the organizers.

February 8

The Chemical Society (Southampton). At the College of Technology, Portsmouth. 7 p.m. Joint meeting with the Portsmouth and District Chemical Society. 'Silicones, Their Properties and Industrial Applications,' by Mr. A. N. Tizard, F.R.I.C.

February 9

The Chemical Society (Aberystwyth). In the Edward Davies Chemical Laboratories, University College, Aberystwyth. 5 p.m. 'Biosynthesis of Terpenoids with Special Reference to Carotenoids,' by Prof. R. W. Goodwin, M.Sc., A.R.I.C.

The Chemical Society (Bristol). In the Department of Chemistry, Bristol University. 5.15 p.m. Joint meeting with the Student Chemical Society. 'The Infrared Spectra of some Inorganic Complexes,' by Dr. D. W. A. Sharp.

February 10

The Chemical Society (Cambridge). In the University Chemical Laboratory, Lensfield Road, Cambridge. 8.30 p.m. Joint meeting with the University Chemical Society. 'The Mobile Stereochemistry of Nitrogen,' by Dr. K. Schofield.

The Chemical Society (Exeter). In the Washington Singer Laboratories, Exeter University. 5 p.m. 'Aspects of Phenol Biogenesis,' by Prof. C. H. Hassall, M.Sc.

The Chemical Society (St. Andrews and Dundee). In the Chemistry Department, St. Salvators College, St. Andrews. 5.15 p.m. Joint meeting with the University of St. Andrews Chemical Society and the Royal Institute of Chemistry. 'Hydrogen Bonding and some Crystal Structures,' by Dr. J. C. Speakman.

The Chemical Society (Southampton). In the Chemistry Department, Southampton University. 5 p.m. Joint meeting with the University Chemical Society. 'The Porphyrin Group of Natural Pigments,' by Prof. A. W. Johnson, D.Sc., Ph.D., A.R.C.S.

February 12

The Society of Instrument Technology (Grangemouth Section). At the Leapark Hotel, Grangemouth. 7 p.m. 'Flame Failure Devices.'

February 13

The Chemical Society (Cambridge). In the University Chemical Laboratory, Lensfield Road, Cambridge. 5 p.m. 'Some Aspects of Aromatic Reactivity,' by Dr. C. Eaborn, A.R.I.C.

The Chemical Society (Durham). In the Science Laboratories, Durham University. 5 p.m. 'Very Fast Chemical Reactions,' by Prof. G.Porter, M.A., Ph.D.

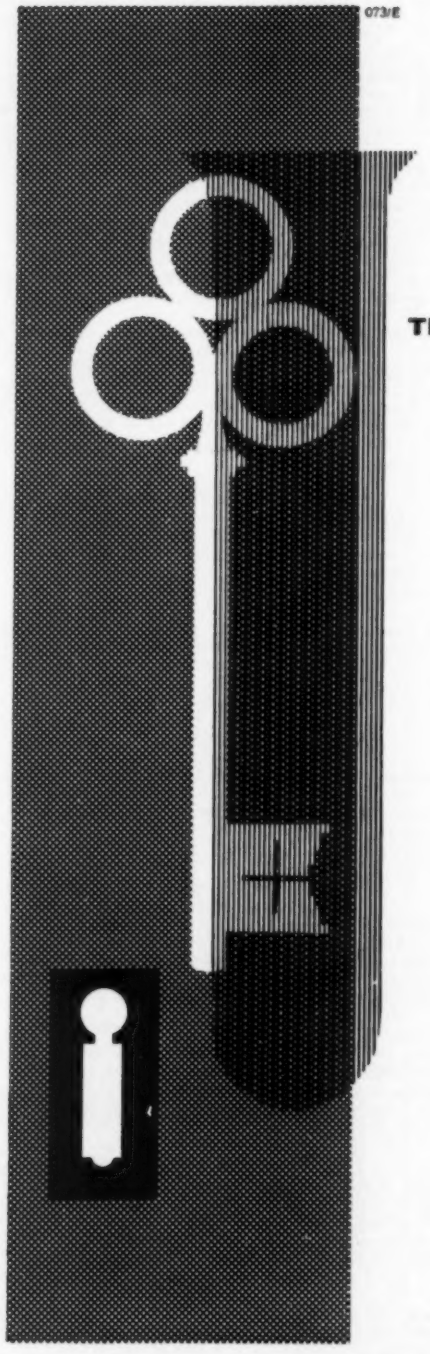
February 14

The Chemical Society (Northern Ireland). In the Chemistry Department, Queen's University, Belfast. 7.45 p.m. 'Recent Advances in Infrared Spectroscopy,' by Dr. L. J. Bellamy.

The Chemical Society (St. Andrews and Dundee). In the Chemistry Department, Queen's College, Dundee. 5 p.m. 'Transition-metal Complexes Derived from Cycloheptatriene,' by Prof. P. L. Pauson, Ph.D.

February 15

The Chemical Society (Tees-side). In the Stockton and Billingham Technical College, Billingham. 8 p.m. Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry. 'Some Developments in Analytical Chemistry,' by Prof. R. Belcher, F.R.I.C.



The key to success

must, first of all, fit the lock. Key and lock form an integral part and nobody will ever try to unlock a safety-lock with the church-door key.
Corresponding parallels are to be found also in chemistry, for example, in analysis the specially tested "Guaranteed Reagents Merck" are "keys that fit".

We supply numerous chemicals in various degrees of purity:

- **purified**
- **pure**
- **extra pure**
- **Guaranteed Reagent**

For every scope the specific preparation is available with us and the right selection only proves the expert.

Let us help solving your problems!

Distributors in the U.K.:
Messrs. ANDERMAN & COMPANY Ltd.
Battlebridge House, 87–95, Tooley Street,
LONDON, S.E.1

E. MERCK AG E. Merck **DARMSTADT**
Germany

February 15 (*continued*)

The Society of Instrument Technology (Newcastle Section). In the Conference Room, Roadway House, Oxford Street, Newcastle-upon-Tyne. 7 p.m. 'The Education and Training of Instrument Artificers,' by B. W. Ramsay, B.Sc., A.R.C.S.

The Society for Analytical Chemistry (Biological Methods Group). In the Meeting Room of the Chemical Society, Burlington House, London, W.1. 7 p.m. 'Use of Enzymes in Biological Assay.'

The Institution of Chemical Engineers. At the Geological Society, Burlington House, London, W.1. 5.30 p.m. Hinchley Memorial Lecture. 'Science and the Developing Countries,' by Prof. P. M. S. Blackett.

February 16

The Chemical Society (Bristol). In the Department of Chemistry, Bristol University. 5.15 p.m. Joint meeting with the Student Chemical Society. 'Death by Poisoning,' by Dr. A. Hunt.

The Chemical Society (Edinburgh). In the North British Station Hotel, Edinburgh. 7.30 p.m. Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry. 'Some Aspects of the Chemistry of Isoquinoline Alkaloids,' by Dr. K. W. Bentley, M.A.

The Chemical Society (Glasgow). In the Chemistry Department, Glasgow University. 4 p.m. Joint meeting with the Alchemists Club. 'Physical Adsorption,' by Prof. D. H. Everett, M.B.E., D.Phil., F.R.I.C.

The Chemical Society (Hull). In the Department of Chemistry, Hull University. 5 p.m. Joint meeting with the University Students Chemical Society. 'The Mechansim of some Organometal substitutions,' by Sir Christopher Ingold, D.Sc., F.R.I.C., F.R.S.

The Society for Analytical Chemistry (Midlands Section). At the General Hospital, Birmingham. 6.30 p.m. Joint meeting with the Association of Clinical Biochemists on Chromatography. Speakers: N. F. Kember, A.R.I.C. and Dr. H. G. Sammons.

February 17

The Chemical Society (Newcastle upon Tyne). In the Chemistry Department, Kings College, Newcastle upon Tyne. 5.30 p.m. Bedson Club Lecture 'Synthetic Fused Silica,' by Dr. K. H. Jack, F.R.I.C.

February 20

The Chemical Society (Aberdeen). In the University Chemistry Department, Old Aberdeen. 8 p.m. Pedler Lecture. 'Some Problems in the Chemistry of the Gallotannins,' by Prof. R. D. Haworth, D.Sc., Ph.D., F.R.S.

February 22

The Institution of Mechanical Engineers. At 1 Birdcage Walk, London, S.W.1. 6 p.m. Thomas Hawksley Lecture. 'Controlled Fusion Reactions,' by Prof. P. M. S. Blackett.

February 23

The Chemical Society (London). In the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7. 10 a.m. All day symposium on Terpene Chemistry arranged by Prof. A. W. Johnson, Ph.D., Sc.D., A.R.C.S., followed by a dinner at Imperial College.

The Chemistry Society (Bristol). In the Department of Chemistry, Bristol University. 6.30 p.m. Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry. 'The Simplest Type of Chemical Reaction,' by Prof. T. L. Cottrell.

The Chemical Society (Liverpool). In the Department of Inorganic and Physical Chemistry, Liverpool University.'Chemical Control of Plant Growth,' by Prof. R. L. Wain, Ph.D., F.R.I.C., F.R.S.

The Chemical Society (Northern Ireland). In the Chemistry Department, Queens University, Belfast. 7.45 p.m. 'The Principles of Radiation Chemistry and the Possibilities of its Industrial Applications,' by Prof. F. S. Dainton, M.A., Ph.D., F.R.S.

The Society of Instrument Technology (Chester Section). In the Lecture Theatre, Administration Building, The Associated Ethyl Company Ltd., Oil Sites Road, Ellesmere Port, Wirral. 7 p.m. 'The Atomic Clock,' by J. V. L. Parry, M.Sc.

The Society for Analytical Chemistry (Western Section). At Gloucester. Joint meeting with the Bristol and District Section of the R.I.C. on 'Titrations in Non-aqueous Solvents,' by E. Minshall, M.Sc., F.R.I.C.

February 24

The Chemical Society (Birmingham). In the Chemistry Department, Birmingham University. 4.30 p.m. 'The Structure of Bacteria,' by Prof. J. Baddiley, D.Sc., Ph.D.

The Chemical Society (Cambridge). In the University Chemical Laboratory, Lensfield Road, Cambridge. 8.30 p.m. 'Recent Advances in the Chemistry of D Vitamins,' by Prof. B. Lythgoe, Ph.D., F.R.I.C., F.R.S.

The Chemical Society (St. Andrews and Dundee). In the Chemistry Department, St. Salvators College, St. Andrews. 5.15 p.m. Joint meeting with the University of St. Andrews Chemical Society. 'Some Problems in the Structural Chemistry of Polysaccharides,' by Prof. E. L. Hirst, C.B.E., D.Sc., F.R.S.

The Chemical Society (Southampton). In the Chemistry Department, Southampton University. 5 p.m. Joint meeting with the University Chemical Society. 'The Spectroscopy of Benzine,' by Dr. D. H. Whiffen, M.A.

The Society of Instrument Technology (Scottish Section). At the Building Centre, Sauchiehall Street, Glasgow, 'Interesting the Instrument Mechanic in Fundamental Principles,' by F. Rout.

The Society for Analytical Chemistry (Scottish Section). At the Royal College of Science and Technology, Glasgow, C.1. Joint meeting with the Royal Institute of Chemistry on 'Ion Exchange.' Speakers: R. A. Wells, B.Sc., A.R.I.C. and V. E. Gripp, B.Sc., A.R.C.S., A.R.I.C.

The Society for Analytical Chemistry (Microchemistry Group). In the Meeting Room of the Chemical Society, Burlington House, London, W.1. 7 p.m. Annual General Meeting followed by the retiring chairman's address.

February 28

The Chemical Society (Durham). In the Science Laboratories, Durham University. 5 p.m. 'The Stereochemistry of Metal Ions,' by Prof. L. E. Orgel, M.A., D.Phil.

The Chemical Society (Tees-side). In the William Newton School, Norton-on-Tees. 8 p.m. Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry. 'Progress and its Effects on our Food Supplies,' by T. McLachlan, D.C.M., F.R.I.C.

The Society for Analytical Chemistry (Physical Methods Group). At the Royal College of Surgeons, London. 6.30 p.m. (Preceded by a visit to the Research Department of Anaesthetics). 'Physical Methods of Analysis used in Medical Research.'

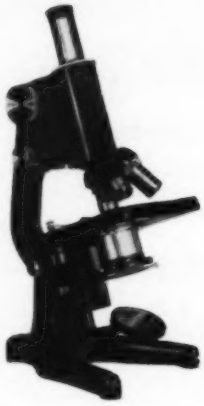
March 1

The Society of Instrument Technology (South Yorkshire Section). At the Metropole Hotel, Leeds. 7 p.m. 'High Speed Instruments for Combustion Research,' by A. E. Pengelly, B.Sc., A.Inst.P.

March 3

The Society for Analytical Chemistry. In the Meeting Room of the Royal Society, Burlington House, London, W.1. 2.15 p.m. Annual General Meeting followed at 2.45 p.m. by address of the retiring president, R. C. Chirnside, F.R.I.C. The Biennial Dinner will be held on the same day at 7.15 p.m. at Fishmongers' Hall, London Bridge, E.C.4.

A fine instrument the WATSON 'Service' . .



The 'Service' is to-day's finest student laboratory microscope. It has simplicity, allied with the highest quality... in fact a fine example of the Watson Standard.

It is built for a lifetime of constant use. There is a comprehensive range of accessories designed to make the 'Service' suitable for more complex work. See the Watson 'Service' before you make your decision. Write to us for full descriptive literature, or arrange an appointment with one of our representatives.

Since 1837 Watsons have been making fine optical instruments to the highest possible standard—the 'Watson Standard'.

WATSON

W. Watson & Sons Ltd.
Barnet, Herts.

Cross infection!

NEW

WIDE SPECTRUM
HYCOLiN
Sterilizing Fluid

increases your safety margin

80 years of constant research and development have resulted in the completion of a finely balanced formula of synthetic phenols in Hycolin—the first stable wide-spectrum sterilizing fluid.

Hycolin has been proved:

- ✳ *100% effective at 2% dilution against Staph. aureus, Ps.pyocyaneus, Streptococcal organisms, Coliform organisms, Myco. T.B. and all common pathogens.*
- ✳ *not affected by blood, pus, serum, or other inhibitors.*
- ✳ *non-toxic and non-escharotic.*

Hycolin has been clinically assessed (Larkin, Bridson & Grieve—in publication); and it is available in three forms—as an antiseptic fluid, as an anti-bacterial cream and as a liquid soap.

It costs only half the price of chlorhexidines.

For technical information and samples, please contact

Pearson's Antiseptic Co. Ltd.

172 Buckingham Palace Road, London, S.W.1.
Tel: Sloane 0077/8

Carboy Hand Pumps

for the safe discharge of

CORROSIVE LIQUIDS

The Hand Pumps enable corrosive liquids to be taken from carboys and bottles with safety, eliminating the risk of accidental burns caused by spillage. Suitable for any carboy or bottle with an inside neck diameter of about ¾ to 2¾ inch. Supplied with lift tube adjustable for different container depths. A valve allows instantaneous flow cut-off or continous siphoning. Drip proof. Available in PVC for acids, alkalis, alcohols, etc., or Polyamid for solvents, esters, ketones, etc. Please write or telephone for leaflet with prices.

GLENCRESTON LTD.

Red House, 37 Broadway, Stanmore, Middlesex

Tel : Grimsdyke 4218

★ **POLYTHENE** ★

ASPIRATOR BOTTLES

½ to 10 galls. CAPACITY

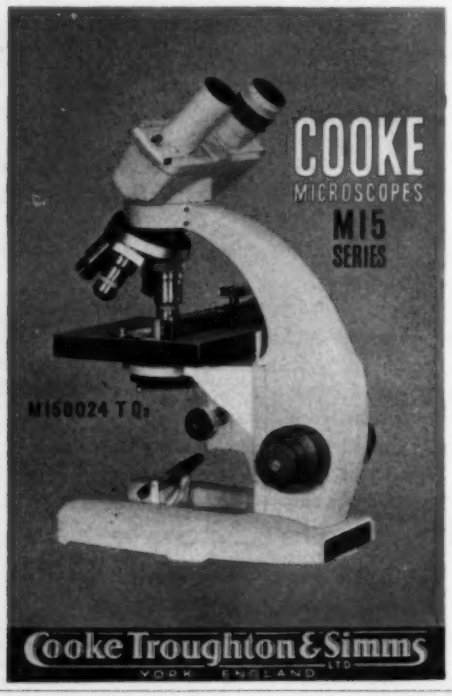
PIPETTE WASHERS & CYLINDERS

LISTS FREE ON APPLICATION

BORO'

LABORATORIES & APPLIANCE CO LTD

1 STATION BUILDINGS, CATFORD, S.E.6



THE 'PORTALAB'

PORTABLE CHEMICAL LABORATORY

DESIGNED BY DR. H. MEDINGER

A complete chemical laboratory, containing ample apparatus and approximately 100 chemicals for work covering the various examinations in Chemistry (Ordinary-level and Advanced-level G.C.E., National Certificate, etc.).

Equipment includes complete apparatus for Gas Preparation, Polythene Pneumatic Trough, Liebig Condenser for Distillation, Thermometer, Graduated Flask, Burette and Pipette (Class B) for Titration, Combustion Tube and Boat, Blow-pipe, Stainless Spatula, etc.

Dimensions: 21" × 15" × 9" Weight 33 lb.

Sturdy construction

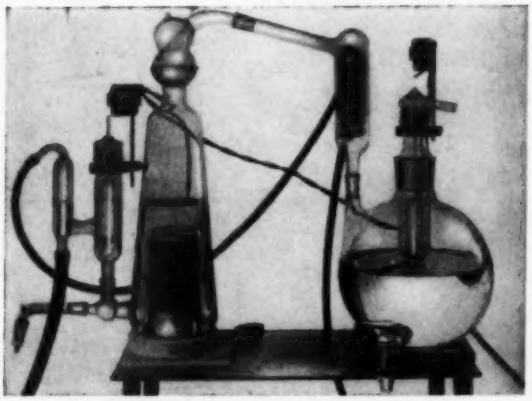
In fitted, polished ply-wood case, with lock and key.

Further particulars and price on application

AIMER PRODUCTS LTD LABORATORY FURNISHERS

56-58 ROCHESTER PLACE, CAMDEN ROAD, LONDON N.W.1

Telephone: GULLIVER 3618 and 6466



This unique water still is in use in a number of research establishments and hospitals where water of the highest purity is essential.

Price complete with heater and all electrical equipment 230 volt (a.c. only)—**£25. 10s. 0d.** inclusive of carriage and packing in U.K.

Obtainable ONLY from

L. V. D. SCORAH, M.Sc.

(Manufacturer of the 'SCORAH' Blowpipe).

44, NORTHFIELD ROAD, KINGS NORTON, BIRMINGHAM, 30. Kings Norton 1885

The SCORAH Automatic Electric all glass WATER STILL (*patented*)

Automatic. Can be left on without attention. Heater current cuts off if water supply is interrupted, or inadequate or forgotten. When receiver (5 litres capacity) is full, current cuts off. When distilled water is drawn from receiver, the still resumes operation until receiver is refilled.

Purity. Electrostatically charged condenser droplets can pick up fumes, dust and air-borne organisms from the laboratory atmosphere. The design of the receiver vessel ensures absence of such contamination.

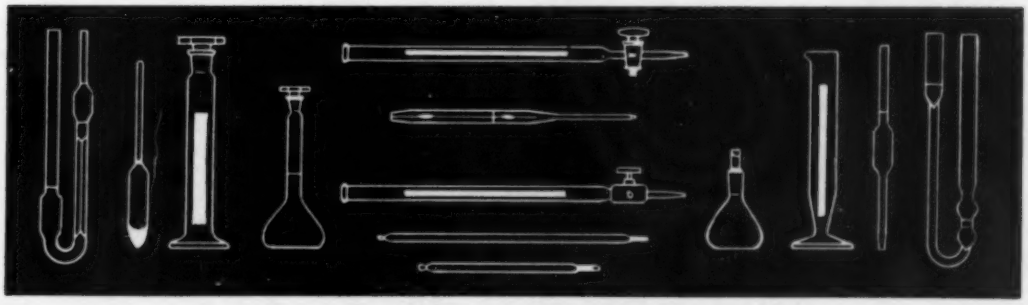
Efficiency. Heater of Scorah design and manufacture, consumption 1700 watts, output 2·4 litres per hour (the full theoretical yield). Cost 3½d. per gallon at 1d. per unit.

Safety. The heating element is out of contact with the feed water thus eliminating danger from 'live' water supply or electrolytic effects or 'burn out'.

Assembly. No retort stands or clamps are required. The 2½" diameter ball joint gives a strainless set-up. Outlet cap on boiler for quick periodical drain-off of sediment. The still may be installed on a shelf or platform about 1 ft. above bench level near a sink and enclosed in a transparent plastic cover to keep out dust. Phoenix heat-resisting glass. Interchangeable ground glass joints.

Specify E·MIL ***for***

DEPENDABILITY



H. J. ELLIOTT LTD

E-MIL WORKS, TREFOREST INDUSTRIAL ESTATE, PONTYPRIDD, GLAMORGAN

GREEN'S PURE FILTER PAPERS

are
Competitive in Price and made to published standards.

Ask for free descriptive book 18 G.60 which gives you the specifications.

J. BARCHAM GREEN LTD.
MAIDSTONE - ENGLAND

SILICA/QUARTZ
Spherical Joints
12-5 18-9 28-15

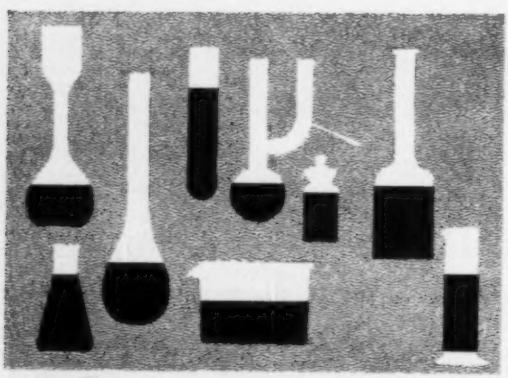
MADE BY jencons IN VITREOSIL
BSS 2761
and
Conical Joints
B5 to B60

Jencons carry complete stocks of Vitreosil tubing at Vitreosil list prices.

Jencons will make your silica/quartz apparatus, combustion tubes, distillation apparatus, etc.

For immediate service **Jencons** *the Silica Centre*

MARK ROAD · HEMEL HEMPSTEAD · HERTS
Telephone **Boxmoor 4641 (5 lines)**



See JP first for all your laboratory equipment

Laboratory Furnishers for over 100 years

You'll be surprised at the extent of the J.P. service—*especially in the North and Midlands.*

J. Preston Ltd

West Street, Sheffield
Tel: 20101 & 20102
Grams: Scientific, Phone, Sheffield

EST. **ZECOL** 1888

Specially designed thermometers for all Laboratory purposes.
Made in accordance with I.P., B.S.I., S.T.P.T.C. & A.S.T.M. specifications.
Short range, short stem, Calorimeter and Secondary Reference Standard thermometers.
N.P.L. Certified if required.

Precision Hydrometers for Density, Specific Gravity and all Arbitrary scales.

Glass sheathed Insulated thermometers for Chemical purposes.

Mercury in Steel, Vapour Pressure and Bimetallic thermometers.

G. H. ZEAL LTD.
LOMBARD RD., MORDEN RD., LONDON, S.W.19
Phone: Liberty 2283/4/5/6. Grams: Zealdom, Souphone, London

S30

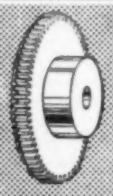
1/30 h.p. Stirrer with Shaft, Propeller and Speed Control

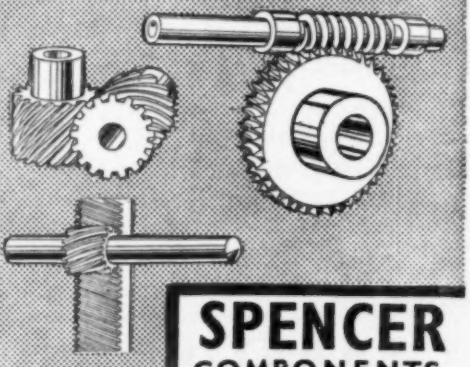
£9.12s.3d.

VOSS

OF MALDON-ESSEX • Phone 517

INSTRUMENT
GEARS
PRECISION MACHINE CUT





SPENCER
COMPONENTS
5 HIGH STREET,
KINGS HEATH,
BIRMINGHAM . 14

Telephone:
HIGhbury
3155

porcelain ball mill pots

These new type ball mill pots with flat ground tops and flat ground interchangeable covers are already popular with a large number of satisfied users. Made of hard porcelain with the excellent properties of resistance to corrosion and abrasion and freedom from contamination. Ideal for dry or wet grinding ceramic colours, chemicals, paints, pharmaceutics, etc.

Available from 1-pint to 5-gallons nominal capacities. Supplied complete with nickel plated metal fittings and with or without ball charges. Nickel plated metal pourers for separating ball and material charges are available for all sizes of ball mill pots.

PASCALL

Write or telephone Crawley 25166 for List PP2502

THE PASCALL ENGINEERING CO LTD
GATWICK ROAD · CRAWLEY · SUSSEX

THIS WILL STIR YOU!

THE NEW
ROSS MICROREADER

is for . . .

ABSORBENT MATS specially made to prevent spilt acids or hot liquids disfiguring bench tops.

AIRLINE TUBING in plastic, celluloid, and rubber.

ASSIMILATION APPARATUS available for various demonstrations. Manufactured in quality materials.

AUTOCLAVES and sterilisers. From 9 to 50 litre capacity with exclusive safety device.

Just a small selection from the vast range of laboratory apparatus available from :

T. GERRARD A COMPANY LIMITED

46-48 PENTONVILLE ROAD • LONDON N.1.
Telephone: Terminus 8006/7

introducing

JAYTEC

REGISTERED TRADE MARK

Graduated Laboratory Glassware

"JAYTEC" volumetric glassware is specially designed for the commercial/technical user requiring fast dispensing accurate instruments for quick use.

A sample box of "JAYTEC" graduated glassware comprising one each of 100ml cylinder, 50ml flask, 1ml measuring pipette, 10ml measuring pipette and a 10ml bulb pipette can be obtained from your usual laboratory supplier for **only 16s. 9d. complete** as a special trial offer.

Please write to us if any difficulty is experienced in obtaining supplies, and your requirements will be given immediate attention.

A full descriptive Price List leaflet can be had on request from the sole manufacturers:

F. R. JONES LIMITED *of*
24 GASKIN STREET, LONDON, N.1

CLASSIFIED ADVERTISEMENT

If you want to emphasise your firm's services or equipment; if you wish to advertise a vacant situation, buy or sell equipment, the Classified Advertisement columns of 'LABORATORY PRACTICE' will prove a valuable medium for your announcement—and bring results quickly.

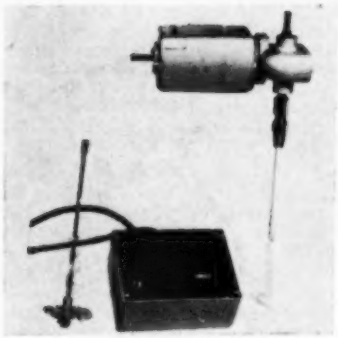
Situations Wanted	— 4d. per word, minimum 6/-
Situations Vacant	— 6d. per word, minimum 10/-
Capacities Available	— 6d. per word, minimum 10/-
Services Available	— 6d. per word, minimum 10/-
Business Opportunities	— 6d. per word, minimum 10/-

Rates for other advertisements may be had on application to:

Classified Advertisement Dept.,

LABORATORY PRACTICE
9 Gough Square, London, E.C.4
Telephone: Fleet Street 3172

THIS WILL STIR YOU!



A high torque transformer controlled geared stirrer complete with chuck for £14 16s. 6d. sent on approval for trial.

Write for details to:

ANDERMAN & Co. LTD

Battlebridge House, 87-95 Tooley Street
London, S.E.1 Telephone HOP 0035

THE NEW

ROSS MICROREADER

First introduced in 1959, the Ross MICROREADER met with immediate success. The ease with which both opaque and transparent records can be viewed has solved microrecord problems which hitherto involved the use of three separate instruments.

Among the many accessories available, the Photographic Attachment MR6 merits special mention as it enables copies to be made from all microrecords including microcards.

Overall Dimensions: Height 17in., Width 8in., Depth 13in., Weight 22½lb., Size of Viewing Screen: 6in. x 7in.

The advantages of this exceptional instrument are fully described in our leaflet which will gladly be sent on request. Demonstrations can also be arranged.

ROSS LIMITED,
CLAPHAM COMMON,
LONDON, S.W.4.
Tel: MACaulay 2472 (10 lines)

ROSS LONDON Est. 1830

FOUNDED HAWKSLEY LONDON IN 1869

CRISTALITE
B.S. 748 HAEMACYTOMETER

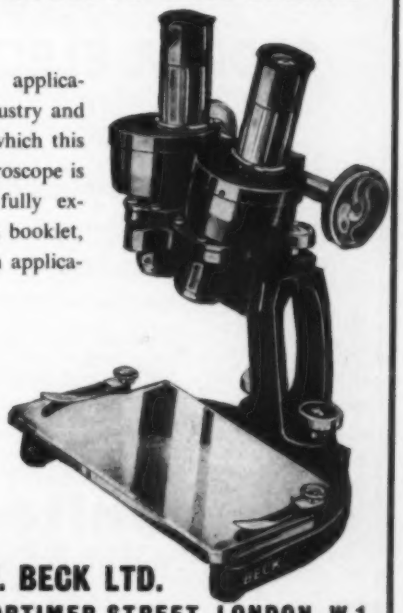
The only metallized haemacytometer made to British Standard 748—the most rigid standard in the world. Details on request.

HAWKSLEY & SONS LIMITED
17 NEW CAVENDISH ST. LONDON W1
WELBECK 8557

BECK LONDON

STEREOSCOPIC BINOCULARS

The many applications in industry and science for which this type of microscope is suited are fully explained in a booklet, post free on application.



R. & J. BECK LTD.
69-71 MORTIMER STREET, LONDON, W.1

Index to Advertisers

CLASSIFIED ADVERTISEMENTS

continued from page 128

SITUATIONS VACANT
(continued)

CHARLES COLSTON LIMITED have a vacancy for an Industrial Chemist to take charge of a small test room at their research and development establishment at present situated near Kingston-on-Thames but shortly to be moved to new premises in the West Middlesex area. The work will initially be concerned with the Colston dish-water and will include research into detergents and surfactants, water-treatment, food soils, corrosion, temperature effect and general life testing. A degree or diploma in Industrial Chemistry or a similar qualification is desirable but not essential. The starting salary will be between £700 and £900 per annum according to age, qualifications and experience and there are good prospects for an able young man with initiative and persistence. There is a pension scheme. Please write with full particulars, including age and present salary, to the Chief Development Engineer, Coombe Woodhouse, Coombe Hill Road, Kingston-on-Thames, marking the envelope 'Confidential'.

FOR SALE

SILICA CONES AND SOCKETS, Vitreosil silica tubing, polished silica discs and glazed sheet always in stock. Custom built silica/quartz apparatus from Jencons, The Silica Centre, Mark Road, Hemel Hempstead, Hertfordshire. Telephone: Boxmoor 4641.

SERVICES AVAILABLE

ELECTRIC FURNACES—For all laboratory and production purposes. 500°C. to 1750°C. Standard sizes. Also specialists in meeting individual requirements. Leading makers for over 30 years. Catterson-Smith Ltd., Exhibition Grounds, Wembley, Middlesex.

NOTICES

ARE You Interested In Animals Without being A Fanatic? Then write for free, illustrated prospectus to UFAW (The Universities Federation for Animal Welfare), 7A Lamb's Conduit Passage, London, W.C.1.

Sole Manufacturers of
GURR'S
(Regd. Trade Mark)
MICROSCOPICAL STAINS & REAGENTS
GEORGE T. GURR, LTD.
136-140 New Kings Road, LONDON, S.W.6

HARPENDEN, HERTS
MODERN AND FULLY EQUIPPED FREEHOLD RESEARCH LABORATORIES
FLOOR SPACE ABOUT 13,000 SQ. FT. ON 2½ ACRE SITE
EXCELLENT CAR PARKING FACILITIES
Apply **KNIGHT, FRANK & RUTLEY**
20 HANOVER SQUARE, W.1 **MAYFAIR 3771**

RADIO & ELECTRONIC COMPONENTS

PUBLISHED MONTHLY

The only journal dealing specially with Radio and Electronic Components, giving particular attention to their design, manufacture, testing and application. Each issue contains a number of technical articles by leading authorities, details of new components, reports on activities in the industry, and other features of interest to manufacturers and users.

Send for specimen copy to :

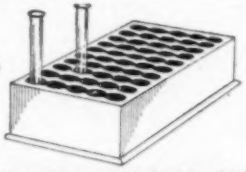
United Trade Press Ltd
BOSWELL HOUSE, 9 GOUGH SQUARE, FLEET STREET, LONDON E.C.4.

Index to Advertisers

Aimer Products Ltd.	120
Anderman & Co. Ltd.	125
Armstrongs (Hull) Ltd.	74
Associated Electrical Industries Ltd.	77
Astell Laboratory Service Co. Ltd.,	82
Baird & Tatlock (London) Ltd.	Cover i
Barcham Green, J., Ltd.	122
Beck, R. & J., Ltd.	125
Beecroft & Partners Ltd.	78
Boro Laboratories & Appliance Co., Ltd.	120
British Drug Houses, Ltd., The	76
British Electrical Resistance Co., Ltd.	January
Brown (Brownall), Donald Ltd.	January
Classified Advertisements	126 & 128
Cooke, Troughton & Simms Ltd.	120
Copley, F. & Co.	127
Difco Laboratories, Inc.	Cover iv
Distillers Co. Ltd., The	74
Electrothermal Engineering Ltd.	December
Elga Products Ltd.	96 & 97
Elliott, H. J., Ltd.	121
Engelhard Industries Ltd.	January
Esco (Rubber) Ltd.	127
Evans Electroselenium Ltd.	January
Flaig, W. G., & Sons Ltd.	January
Gallenkamp, A., & Co., Ltd.	Cover ii
Gerrard, T., & Co. Limited	124
Glen Creston Ltd.	120
Griffin & George Ltd.	86
Gurr, Edward, Ltd.	127
Gurr, George T., Ltd.	126
Hawksley & Sons Ltd.	125
Hearson, Charles & Co., Ltd.	80
Hedin Limited	72
Hopkin & Williams Ltd.	Cover iii
International Combustion Products Ltd.	67
Isopad Ltd.	75
Jencons (Scientific) Ltd.	122
Jobling, James, A., & Co. Ltd.	68 & 69
Jones, F. R., Ltd.	124
Lock, A. M., & Co., Ltd.	70
Loughborough Glass Co. Ltd.	65
May & Baker Ltd.	January
Merck, E., A. G.	117
Moncrieff, John, Ltd.	66
North of England School Furnishing Co. Ltd.	76
Orme Scientific Ltd.	78
Oxo Ltd., (Oxoid Division)	73 & 81
Pascall Eng. Co., Ltd.	72 & 123
Pearson's Antiseptic Co. Ltd.	119
Preston, J., Ltd.	122
Rank Precision Industries Ltd.	71
Reeve, Angel, H., Co. Ltd.	January
Ross Ltd.	125
Scientific Furnishings Ltd.	83
Scorah, L. V. D., M.Sc.	121
Spencer Components	123
Stanton Instruments Ltd.	January
Sugar Manufacturers Supply Co. Ltd., The	January
Surgical Equipment Supplies Ltd.	70
Swift, James, & Son, Ltd.	80
Taylor Rustless Fittings Co., Ltd.	January
Thermal Syndicate Ltd., The	79
Voss Instruments Ltd.	123
Watson, W., & Sons Ltd.	119
West Instrument Ltd.	January
Wild-Barfield Electrical Furnaces Ltd.	82
Zeal, G. H., Ltd.	122

Pat. applied for

Details of available sizes supplied on request.



Rubber Holders: 20/- each

Plastic Holders: 16/- each

"E.R.L." HOLDERS for TEST TUBES, AMPOULES, BOTTLES, etc.

In 8 sizes either in black synthetic rubber, orange plastic or softer red organic rubber

ESCO (RUBBER) LTD.

Manufacturers of Rubber, Silicone Rubber and Plastic Products

34-36 Somerford Grove, London, N.16.

MICHROME STAINS

& Reagents for Microscopy, Histochemistry etc

Adenosin. Carminic Acid. Cytase. Fettrot. Giemsa. Janus green Lacmoid. Leishman. Pyronin. Thionin. Lipase. Mannitol Ribonuclease. Toluidine blue. TPN. Urease. etc

TRIFALGIC ACID, for electrophoresis etc. (ref. *Bodman, J. (1960), Ivor Smith's Chromatographic & Electrophoretic Techniques Vol. 2 (Heinnemann).*

62 page Catalogue available on request.

New books by Edward Gurr

ENCYCLOPAEDIA OF MICROSCOPIC STAINS

500 pages Royal 8vo., price 95/-

EDWARD GURR LTD.,

42, Upper Richmond Road West, London, S.W.14

Your **MIDLANDS** *Specialists in Continental and American Apparatus and Instruments*

Midland Area Distributors:

SARTORIUS BALANCES

When you are thinking of weighing instruments there is something very special about the name "SARTORIUS." You really ought to see and try these superb instruments when you are choosing a new Balance.

F. COPLEY & CO.

WOLLATON ROAD

BEESTON, NOTTINGHAM

CLASSIFIED ADVERTISEMENTS

All advertisements must be PREPAID. Situations Wanted, 4d. per word. Minimum 6s. All other advertisements, 6d. per word minimum of 10s. Semi-display advertisements 4s. per line, minimum £2. Display advertisements at tariff rates. Box Numbers count as four words. Replies forwarded 1s. extra. Replies to Box Numbers must be addressed to *Laboratory Practice*, 9 Gough Square, Fleet Street, London, E.C.4.

The Proprietors reserve to themselves the right to refuse to insert an advertisement if they think proper to do so. All possible care is taken to ensure accuracy in setting up the advertisements, but should an error be made the Proprietors will not hold themselves responsible in any way for same.

SITUATIONS VACANT

RESEARCH CHEMIST. University graduate 30-35 with practical experience in dye-stuffs, oils and surface-active agents. Excellent prospects, housing near London provided. Write confidentially, Box No. 138.

ANALYTICAL CHEMIST

required for overseas post to take charge expanding laboratory handling wide variety organic substances as well as mineral ores. Qualifications: B.Sc. Chemistry with several years' experience of commercial or public laboratory work in organic chemistry coupled with some practical experience of inorganic analysis. Experience of laboratory work in tropical climates an advantage. Generous salary.

Write giving full particulars to Box No. 139.

The Manchester College of Science & Technology,
Sackville Street, Manchester 1.

A Senior Technician or a Chief Technician required in the Chemistry Department to join a chemistry research group and specifically to control and operate a High Resolution Nuclear Magnetic Resonance Spectrometer. Previous experience in this technique is not essential, but candidates should have a good knowledge of electronics or applied physics, and be interested in the further development of the technique for use in chemical research.

Salary—Senior Technician £700-765 per annum (with additions for approved qualifications).

Chief Technician £825-£925 per annum.

40 hour week. Superannuation scheme.

Applications with full details quoting reference No. C. 6 to The Bursar. Closing date, 14th February, 1961.

LABORATORY TECHNICIANS, age 20-25 years, are offered the opportunity of applying their technical experience in industry. Interesting and progressive employment is available in the Scientific Glassware Industry; five day week and Pension Scheme. Applicants should apply in confidence for full particulars from Works Director, A. Gallenkamp & Co. Ltd., Worsley Bridge Road, Lower Sydenham, London, S.E. 26. (One minute from Lower Sydenham Station.)

TECHNICAL ASSISTANTS

Glaxo Laboratories Limited
Ulverston

have the following vacancies

1. Staff for their Process Investigation Laboratory for interesting work connected with the manufacture of antibiotics. Applications are invited from men aged 18-25 who have desirably passed Chemistry at G.C.E. 'A' level or equivalent.
2. Staff for their Analytical Laboratory. Applicants should be men who possess a minimum qualification of 5 G.C.E. 'O' level subjects, two of which must be scientific or O.N.C. in Chemistry. Shift work is involved.

Excellent conditions of employment including Pension Scheme, facilities for further study and the opportunity to participate in the Company's profitability.

Apply in writing to:

The Personnel Officer
GLAXO LABORATORIES Ltd.
Ulverston, Lancs.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
(University of Reading)

Assistant Experimental Officer required in Physics department to assist in studies of physical properties of dairy products —butter and cheese etc. He will also be required to construct and modify experimental testing equipment in the department workshop, and skill in using a lathe would be advantageous. Candidates should possess H.N.C. or pass degree, or, if under 22, G.C.E. 'A' level or equivalent. Starting salary within range £450. 10s. 0d. (at 18) to £776 (at 26) in scale to £983; pension scheme. Apply, naming two referees to Secretary, N.I.R.D., Shinfield, Reading. *Quote ref. 61/4.*

BEDFORD COLLEGE (University of London), Regent's Park, N.W.1. TECHNICIAN required with some knowledge and experience of maintaining instruments and electronics apparatus. Salary range £490-£815 per annum, according to qualifications and experience, plus London Weighting. Good prospects of promotion. Applications to the Secretary.

UNIVERSITY OF NEW ENGLAND
Armidale, New South Wales

LABORATORY ASSISTANTS AND TECHNICIANS

Applications are invited for appointment to positions of Laboratory Assistant and Technician in the Faculty or Rural Science. Applications will be received from people who are qualified to assist with teaching and research in chemistry, including biochemistry and plant and soil chemistry, physiology, microbiology and pathology.

In-service training may be undertaken towards a Diploma in Science Technology.

Commencing wages will be fixed according to qualifications and experience up to £A26. 5s. 9d. per week (males) and £A22. 8s. 10d. per week (females) subject to future variations in the basic wage. Four weeks annual leave; liberal sick leave and long service leave. Fares will be paid and removal expenses of up to £A200.

Applications from within Australia and New Zealand should be forwarded to reach undersigned not later than **24th February, 1961.** Applicants outside Australia and New Zealand should forward their applications to the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1, by the same date. They should also forward an additional copy of their application by air mail to the undersigned.

Applications should give full particulars of qualifications and experience, together with the names of two referees.

T. C. Lamble,
REGISTRAR,
University of New England,
Armidale, N.S.W., Australia.

University of Canterbury
Christchurch, New Zealand

SENIOR TECHNICIAN—ZOOLOGY DEPARTMENT

Applications are invited for the abovementioned post. Applicants should have training in histological techniques and the preparation of teaching material.

The salary range for this position is £965 to £1,125 per annum; commencing salary according to qualifications and experience.

Further particulars and information as to the method of application should be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

Applications close on 15th February, 1961.

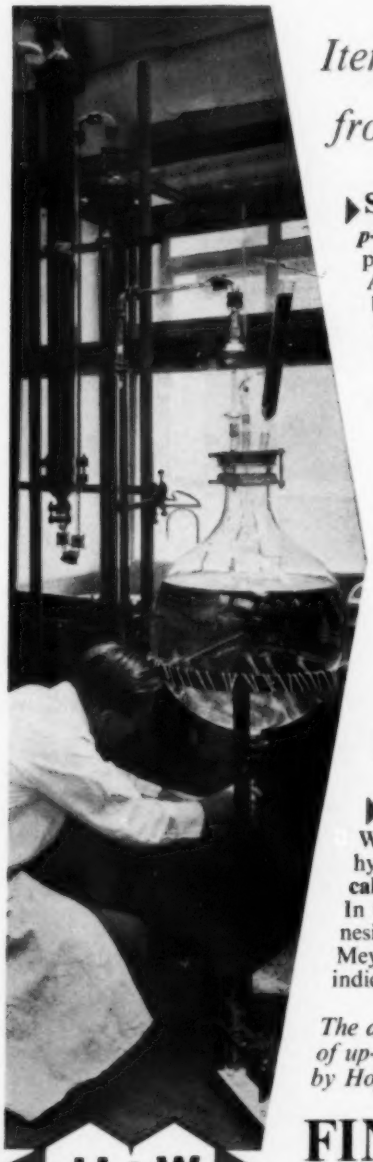
CLASSIFIED ADVERTISEMENTS

continued on page 126

Published by the Proprietors, UNITED TRADE PRESS, LTD., 9 Gough Square, Fleet Street, London, E.C.4, and printed at THE GRANGE PRESS, Southwick, Sussex. Annual subscription rate 45/- (which includes postage) to be sent direct to UNITED TRADE PRESS, LTD., 9 Gough Square, Fleet Street, London, E.C.4, England.

Incidental Information

No. 14



Items of interest

from our laboratory notebooks

Simplified milk phosphatase test

***p*-Nitrophenylphosphoric acid, disodium salt** (*di*-sodium *p*-nitrophenyl phosphate) is used as a substrate in the **milk phosphatase** test of Aschaffenburg and Mullen now gaining in popularity and recognition because of its simplicity and speed. (See *J. Dairy Res.*, **16,** 58 (1949), and *Dairy Ind.*, **18,** 316 (1953)).

We make the reagent and can supply from stock. A suitable Lovibond Comparator for this test is obtainable from Baird & Tatlock (London) Ltd.

Karl Fischer catalyst

This well known method for the determination of **water** is widened in scope and increased in precision by the use of **Karl Fischer Catalyst** (*N*-ethylpiperidine)—available with instructions from Hopkin & Williams Ltd Please write for instruction leaflet.

Uranium by spectrophotometry

Our **1-(2-pyridylazo)-2-naphthol (PAN** for short), already known as a metal indicator for complexometric titrations, (H. Flaschka and H. Abdine, *Mikrochim. Acta*, 770 (1956); *Anal. Abs.*, **4,** 794 (1957)) is now described as a spectrophotometric reagent of high specificity for **uranium** (H. Shibata, *Anal. Chim. Acta*, **22,** 479 (1960)).

Sensitive reagent for Calcium

We also make **di-(*o*-hydroxyphenylimino) ethane** (glyoxal-bis-(2-hydroxy anil)), a specific colour reagent for microgram quantities of **calcium** in solution.

In the solid state calcium oxide can be detected in mixtures of magnesium, strontium and barium oxides. (D. Goldstein and C. Stark-Meyers, *Anal. Chim. Acta*, **19,** 437 (1958)). Its use as a complexometric indicator is described by Goldstein in *Anal. Chim. Acta*, **21,** 339 (1959).

The above are further examples of the great range of up-to-date reagents made available by Hopkin & Williams Ltd.

H & W

FINE CHEMICALS

for research, analysis and industry

HOPKIN & WILLIAMS LTD., CHADWELL HEATH, ESSEX, ENGLAND

Branches: London, Manchester, Glasgow *Agents throughout U.K. and all over the world*

TAS.HW.13

DIFCO

microbiological reagents and media are the only complete line offered in U.K.

Requirements of the Bacteriologist, Biochemist, Biologist, Pathologist and Pharmacologist can be met very quickly either from our extensive stocks, or in the case of certain specialised products, within a few days.

Over 60 years experience ensure

UNIFORMITY
STABILITY
ECONOMY

Culture Media
Microbiological Assay Media
Tissue Culture Media
Serological Reagents
Antisera
Diagnostic Reagents
Sensitivity Disks
Unidisks
Peptones
Hydrolysates
Amino Acids
Enzymes
Enrichments
Dyes
Indicators
Carbohydrates
Biochemicals

Please send for the latest technical information.

BTL complete laboratory service

BAIRD & TATLOCK (LONDON) LTD., CHADWELL HEATH, ESSEX, ENGLAND.
Branches in London Manchester and Glasgow.